AC LOAD LINE

Consider the dc equivalent circuit fig. 1.

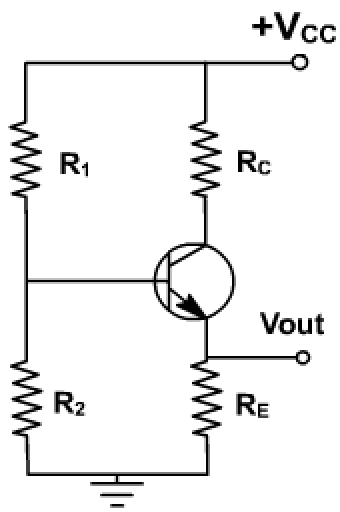

Fig. 1

Assuming $I_C = I_C$(approx), the output circuit voltage equation can be written as

$$V_{CE} = V_{CC} - I_C(R_C + R_E)$$

$$\text{and} \quad I_C = -\frac{V_{CE}}{R_C + R_E} + \frac{V_{CC}}{R_C + R_E}$$

$$V_{CE} = 0, \quad I_C = \frac{V_{CC}}{R_C + R_E}$$

$$\text{and} \quad I_C = 0, \quad V_{CE} = V_{CC}$$

The slop of the d.c load line is $-\frac{1}{R_C + R_E}$.

When considering the ac equivalent circuit, the output impedance becomes $R_C \parallel R_L$ which is less than $(R_C + R_E)$.

In the absence of ac signal, this load line passes through Q point. Therefore ac load line is a line of slope $(-1 / (R_C \parallel R_L))$ passing through Q point. Therefore, the output voltage fluctuations will now be corresponding to ac load line as shown in fig. 2. Under this condition, Q-point is not in the middle of load line, therefore Q-point is selected slightly upward, means slightly shifted to saturation side.

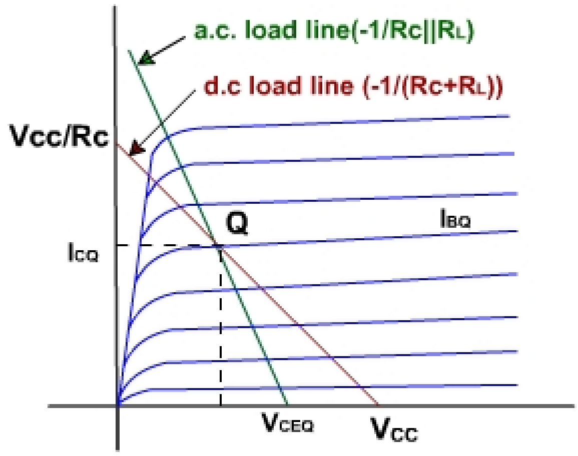

Fig. 2

Voltage gain:

To find the voltage gain, consider an unloaded CE amplifier. The ac equivalent circuit is shown in fig. 3. The transistor can be replaced by its collector equivalent model i.e. a current source and emitter diode which offers ac resistance r'_e.

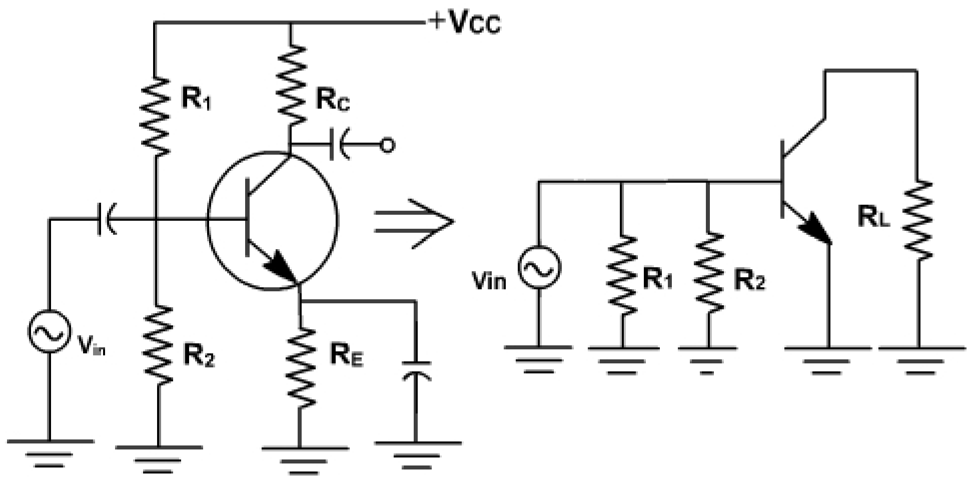

Fig. 3

The input voltage appears directly across the emitter diode.

Therefore emitter current $i_e = V_{in} / r'_e$.

Since, collector current approximately equals emitter current and $i_C = i_e$ and $v_{out} = - i_e R_C$ (The minus sign is used here to indicate phase inversion)

Further $v_{out} = - (V_{in} R_C) / r'_e$

Therefore voltage gain $A = v_{out} / v_{in} = -R_C / r'_e$

The ac source driving an amplifier has to supply alternating current to the amplifier. The input impedance of an amplifier determines how much current the amplifier takes from the ac source.

In a normal frequency range of an amplifier, where all capacitors look like ac shorts and other reactance are negligible, the ac input impedance is defined as

$z_{in}= v_{in}/ i_{in}$

Where v_{in}, i_{in} are peak to peak values or rms values

The impedance looking directly into the base is symbolized $z_{in\ (base)}$ and is given by

$Z_{\ in(base)} = v_{in} / i_b$,

Since,$v_{\ in} = i_e r'_e$

» b_i b r'_e

$z_{in\ (base)} = b\ r'_e$.

From the ac equivalent circuit, the input impedance z_{in} is the parallel combination of R_1 , R_2 and b r'_e.

$Z_{in} = R_1 \| R_2 \| b\ r'_e$

The Thevenin voltage appearing at the output is

$v_{out} = A\, v_{in}$

The Thevenin impedance is the parallel combination of R_C and the internal impedance of the current source. The collector current source is an ideal source, therefore it has an infinite internal impedance.

$z_{out} = R_C$. The simplified ac equivalent circuit is shown in fig. 4.

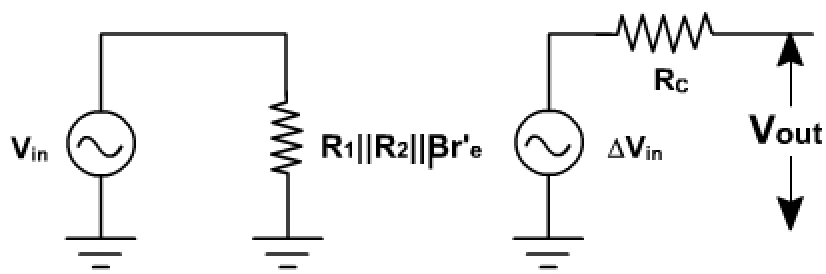

Fig. 4