- The small signal voltage amplification of a Common Emitter amplifier is given by:–

$$A_V = -\frac{I_E}{25mV} \times R_C$$

- The input impedance is given by:–

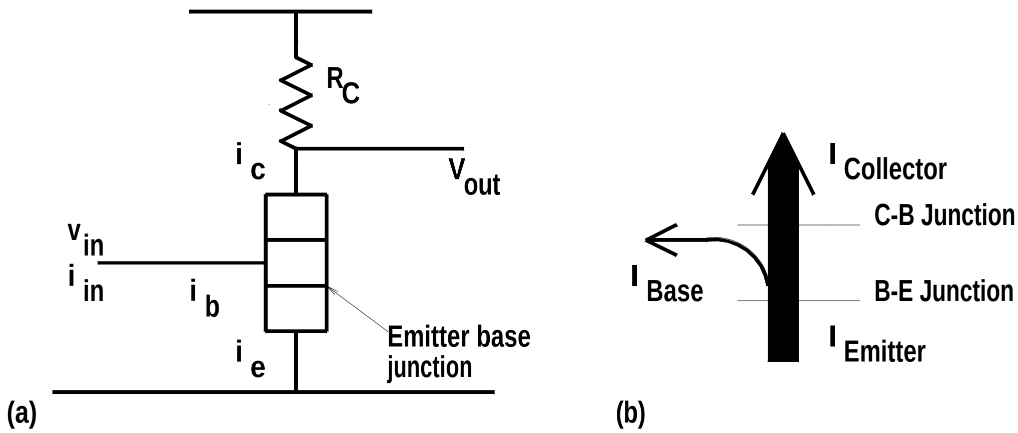
$$R_{in} = \beta \times \frac{25mV}{I_E}$$

Last unit:– How amplification of small signals is obtained.
This unit:–Numerical value of the voltage amplification, A_V

The case of the common emitter amplifier.

Current gain, β, of the transistor is not the same as the amplification, A_V, of the complete transistor circuit.

Circuit amplification determined by β in conjunction with the resistors used in the circuit.



Consider the stripped down circuit shown

Consider only the small signals represented by the lower case letters, v and i.

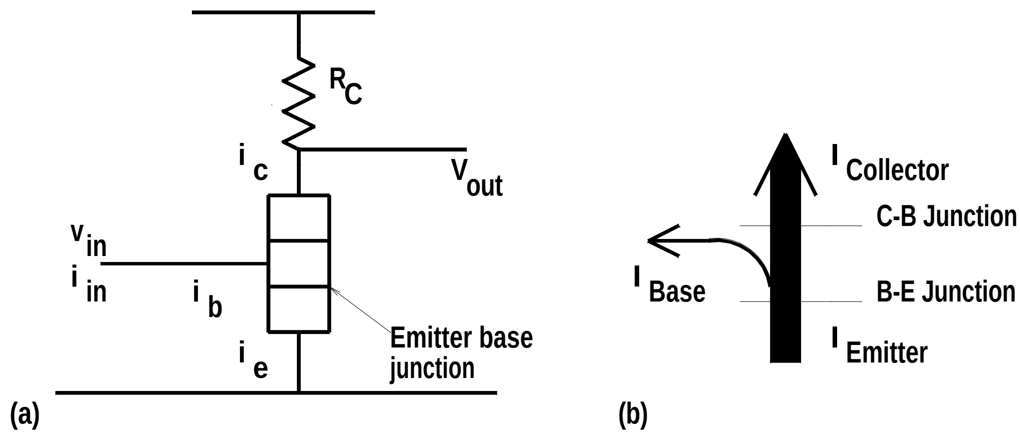
Input resistance is $R_{in} = \frac{v_{in}}{i_{in}}$

Also have equalities $v_b = v_{in}$ and $i_b = i_{in}$.

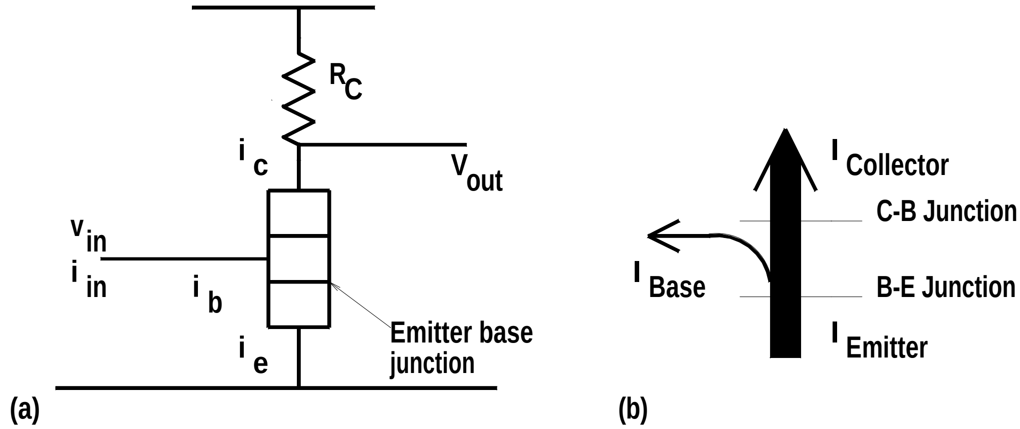
Assume input signals are small enough that any deviation from a linear approximation is negligible.

Easily checked by using an oscilloscope to observe the output waveform.

If output changes only in amplitude as the input signal is increased then the system is effectively a linear system.
If the shape of the waveform is distorted then the system is nonlinear.



Change in base voltage appears as a change in emitter–base junction voltage.
This gives a change in the current through the emitter–base junction of i_e.
A change in the **base** voltage gives a change in the **emitter** current which flows through the emitter– base junction.
Most of this emitter current flows through the base region to the collector
Only a small fraction appears as i_b.



The emitter–base junction

$$R_{DYN} = \frac{25mV}{\text{Junction current}} = \frac{25mV}{I_E}$$

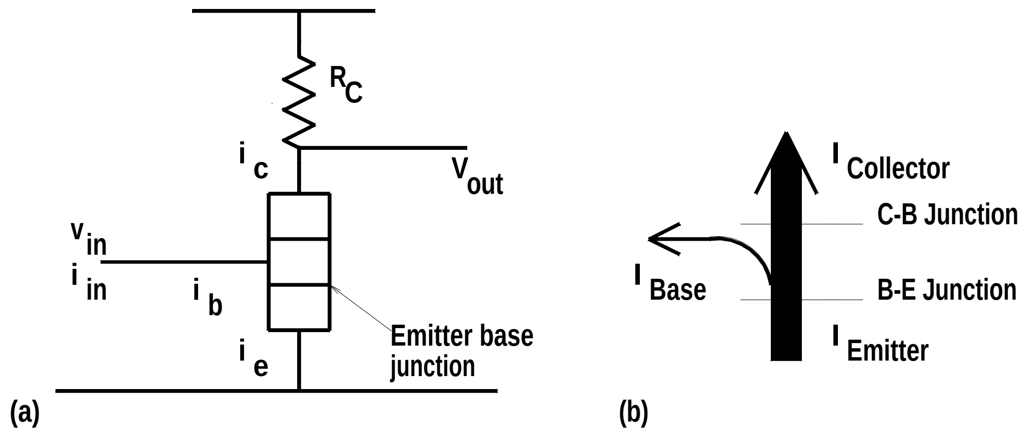
We use DC value, I_E, of the emitter current

$$\frac{v_b}{i_e} = R_{DYN} = \frac{25mV}{I_E}$$

which gives $$v_{in} = v_b = i_e \times \frac{25mV}{I_E}$$

but we also have an output voltage signal

$$v_{out} = -i_c \times R_C \approx -i_e \times R_C$$

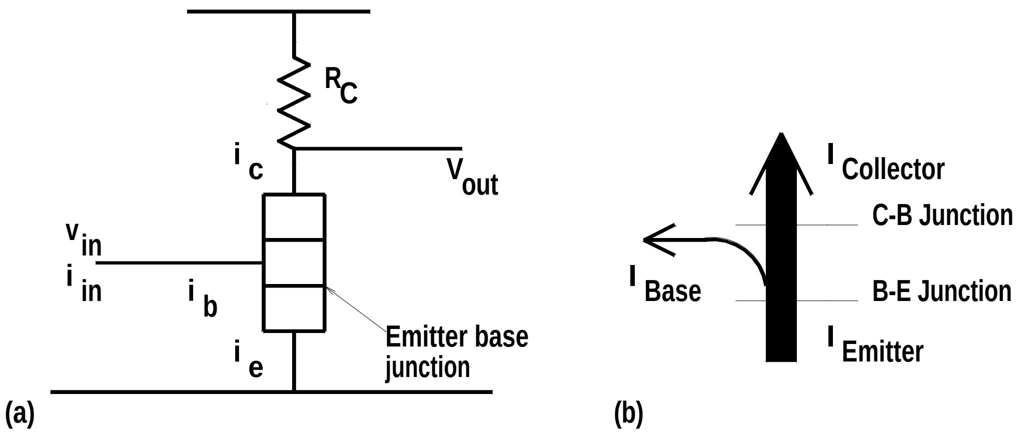


Now we can get the small signal voltage amplification for the amplifier circuit as:—

$$A_V = \frac{v_{out}}{v_{in}} = -\frac{i_e \times R_C}{i_e \times \frac{25mV}{I_E}} = -\frac{I_E}{25mV} \times R_C$$

Negative sign indicates signal is inverted.

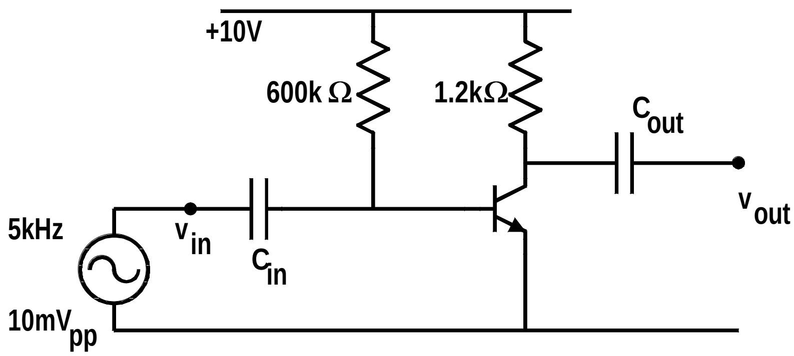
Unexpected feature:– does not contain explicit reference to the current gain, β, of the transistor.



Now consider the Thévenin input resistance

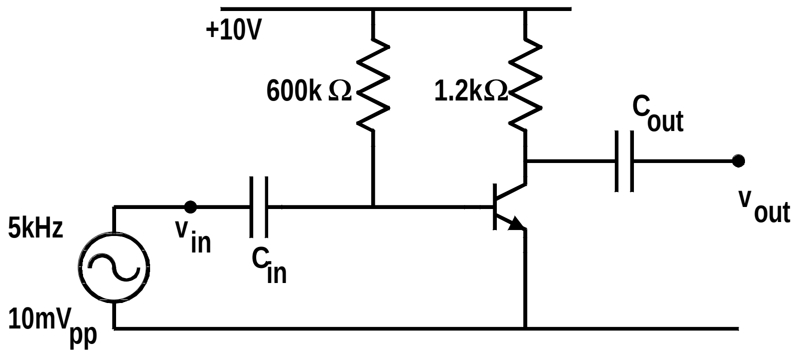
$$
\begin{aligned}
R_{in} &= \frac{v_b}{i_b} \\
&= \frac{i_e \times \frac{25mV}{I_E}}{i_b} \\
&= \frac{\beta \times i_b \times \frac{25mV}{I_E}}{i_b} \\
&= \beta \times \frac{25mV}{I_E}
\end{aligned}
$$

So the input resistance is β times the dynamic resistance of the emitter–base junction.



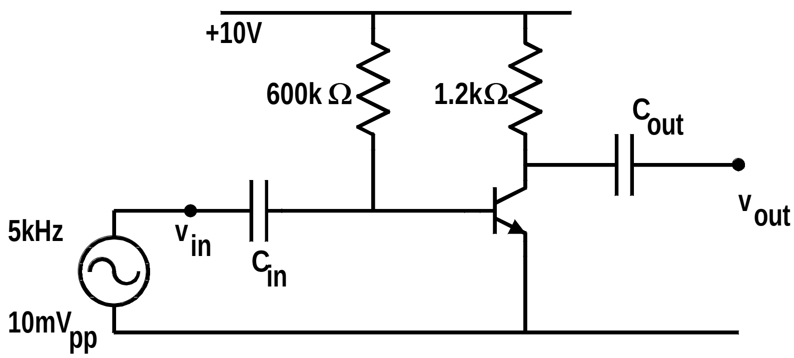
Calculate the amplification and the input resistance of the circuit shown in Figure 33.2. $\beta = 200$.

Give a sketch of the signals which would be observed on an oscilloscope connected in turn to each of the nodes of the circuit.



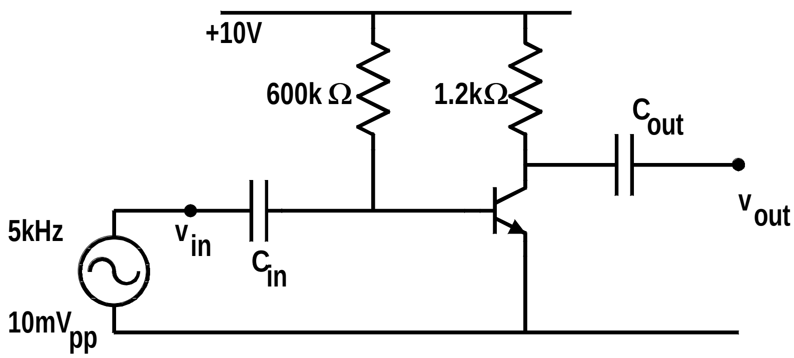
It is necessary to determine the DC operating conditions for the circuit.

$$
\begin{aligned}
V_E &= 0V \\
V_B &= 0.7V \\
10V &= I_B \times 600k\Omega + 0.7 \\
I_B &= \frac{9.3}{600k\Omega} = 15.5\mu A \\
I_E &= I_C = \beta \times I_B = 3.1mA \\
V_C &= 10V - I_C \times R_C = 10 - 3.1mA \times 1.2k\Omega \\
&= 6.28V
\end{aligned}
$$



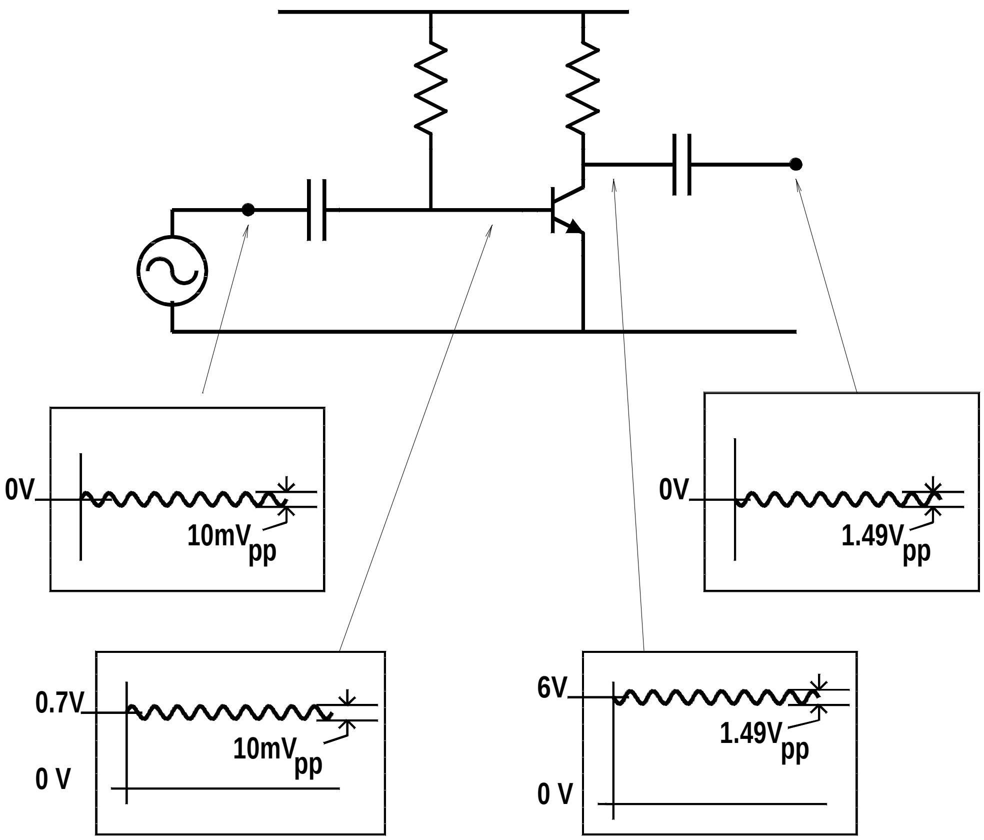
Now calculate the small signal voltage amplification.

$$
\begin{aligned}
A_V &= -R_C \times \frac{I_E}{25mV} = -1200 \times \frac{3.1mA}{25mV} \\
&= -149 \\
R_{in} &= \beta \times \frac{25mV}{I_E} = 200 \times \frac{25mV}{3.1mA} \\
&= 1.6k\Omega
\end{aligned}
$$



If the signal frequency is high enough for the impedance of the C_{in} to be negligible compared with $1.6k\Omega$ then the small signal input impedance is resistive and $1.6k\Omega$. Otherwise we have an effective high pass filter at the input to the amplifier which blocks DC and low frequency AC signals from reaching the transistor. This gives an amplifier frequency response with a corner frequency at

$$f_c = \frac{1}{2\pi C_{in} R_{in}}$$



The signals at various points in a common emitter amplifier