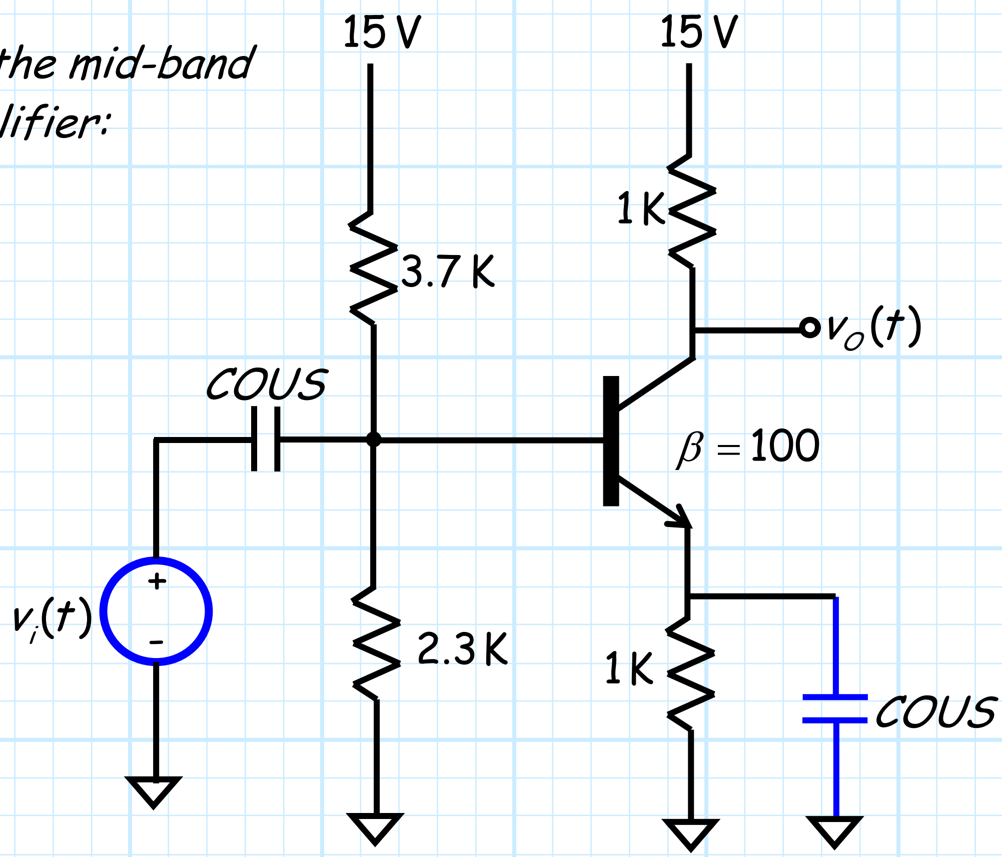
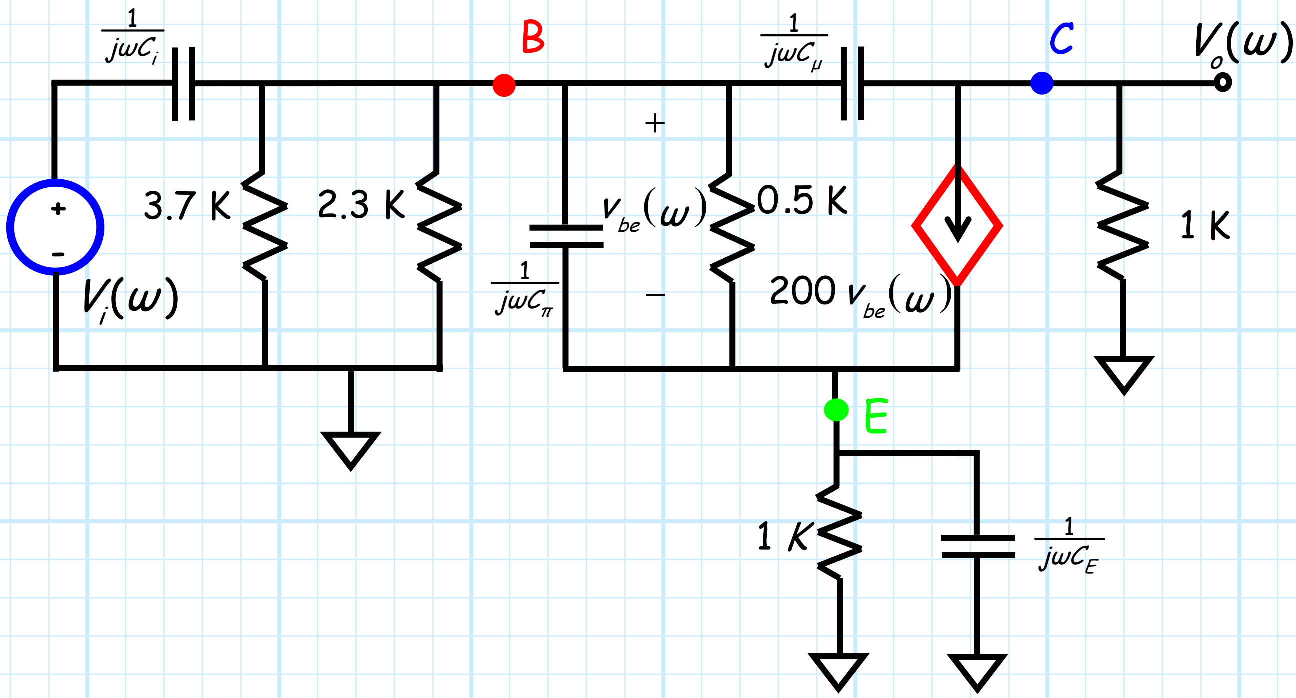
Mid-band Gain

Q: *So, to find the mid-band gain of **this** amplifier:*



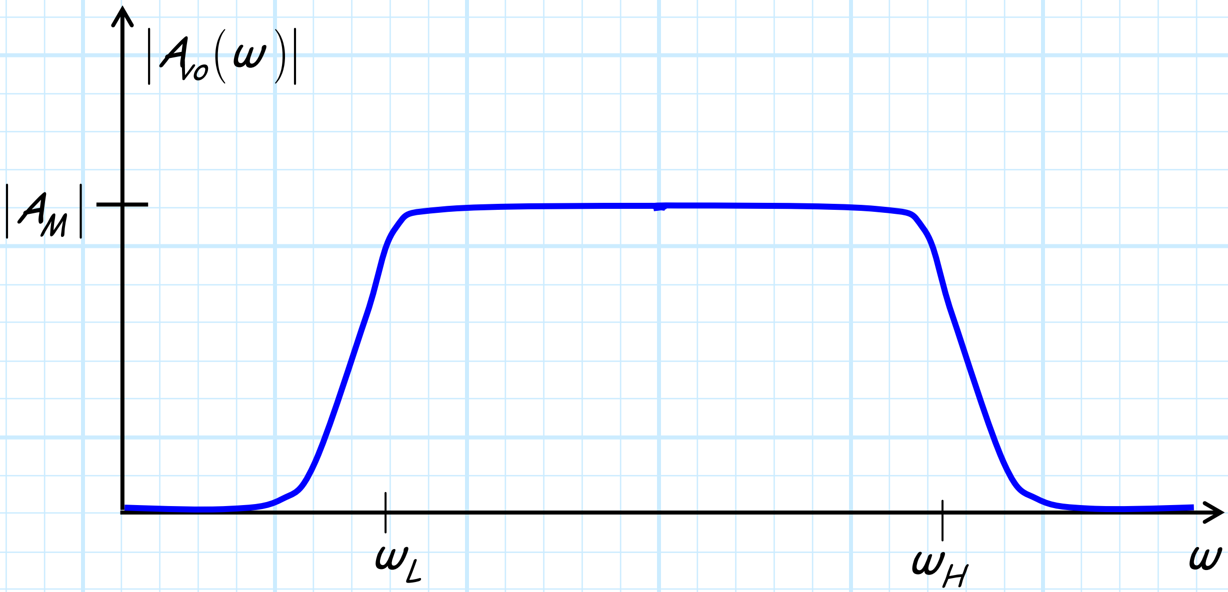
we must find the analyze this small signal circuit:



to determine:

$$A_{vo}(\omega) = \frac{V_o(\omega)}{V_i(\omega)}$$

and then plotting the magnitude:



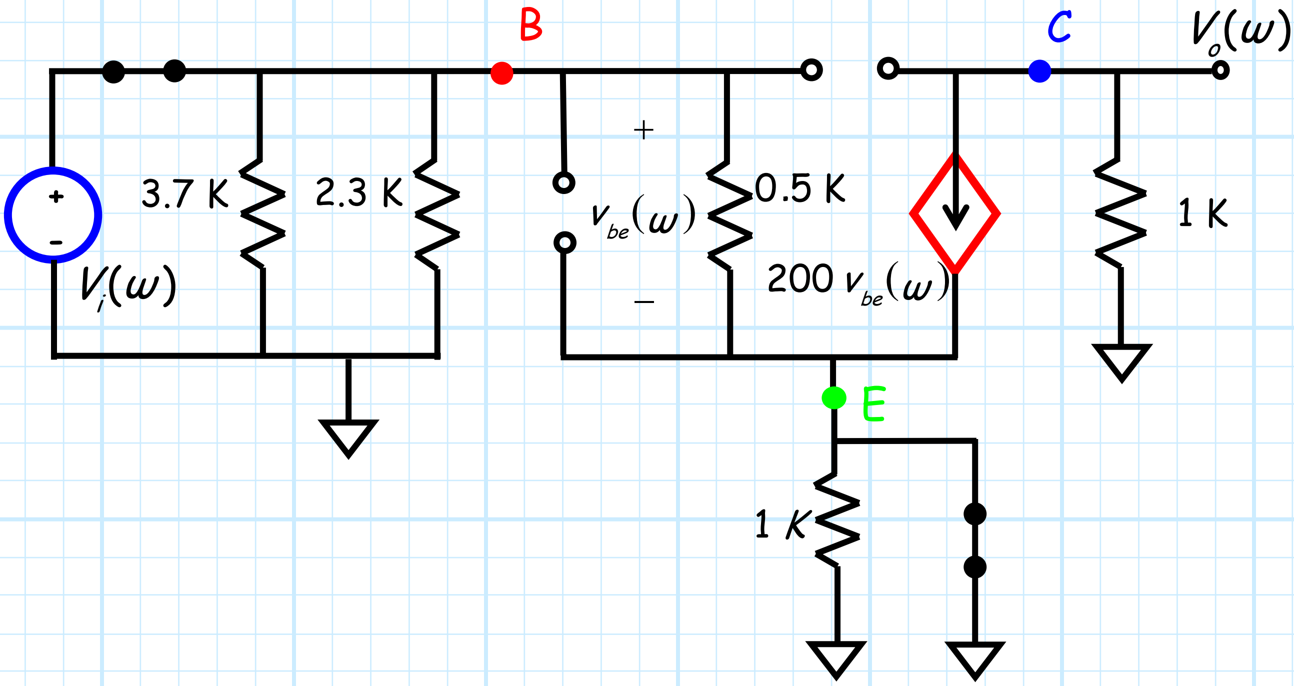
we determine mid-band gain A_M, right?

A: You **could** do all that, but there is an easier way.

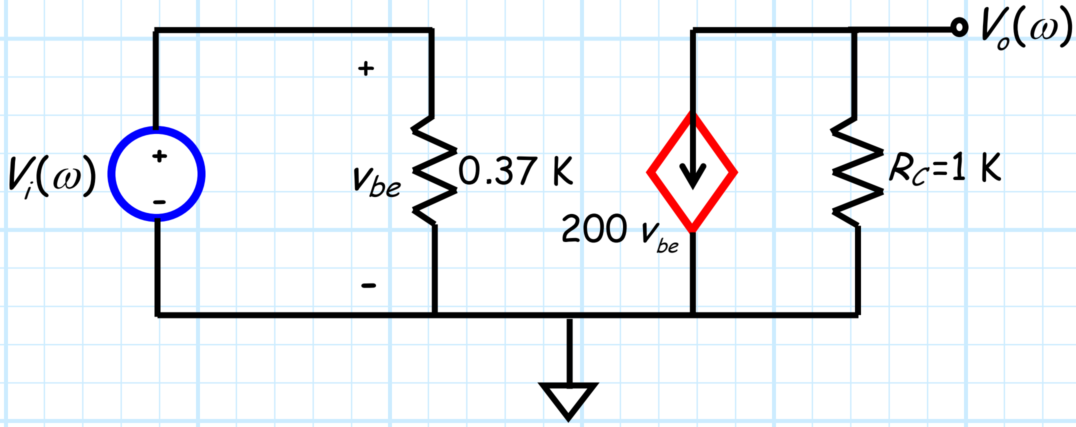
Recall the midband gain is the value af $|A_{vo}(\omega)|$ for frequencies within the amplifier bandwidth. For those frequencies, the AC coupling capacitors (i.e., COUS) are approximate AC short-circuits (i.e., very low impedance) .

Likewise, for the signal frequencies within the amplifier bandwidth, the parasitic BJT capacitances are approximate AC open-circuits (i.e., very high impedance).

Thus, we can apply these approximations to the capacitors in our small-signal circuit:



Now simplifying this circuit (look, no capacitors!):



Q: *Hey wait! Isn't this the same small-signal circuit that we analyzed earlier, where we found that:*

$$v_o(t) = -200\, v_i(t) \quad ??$$

A: It is exactly!

All of the small-signal analysis that we performed **previously** (i.e., the circuits with **no capacitors**!) actually provided us with the **mid-band** amplifier gain.

Taking the Fourier transform of the equation above:

$$\begin{aligned} V_o(\omega) &= -200\, V_i(\omega) \\ &= e^{j\pi} 200\, V_i(\omega) \end{aligned}$$

Thus, the midband gain of this amplifier is:

$$A_M = -200 = e^{j\pi} 200$$