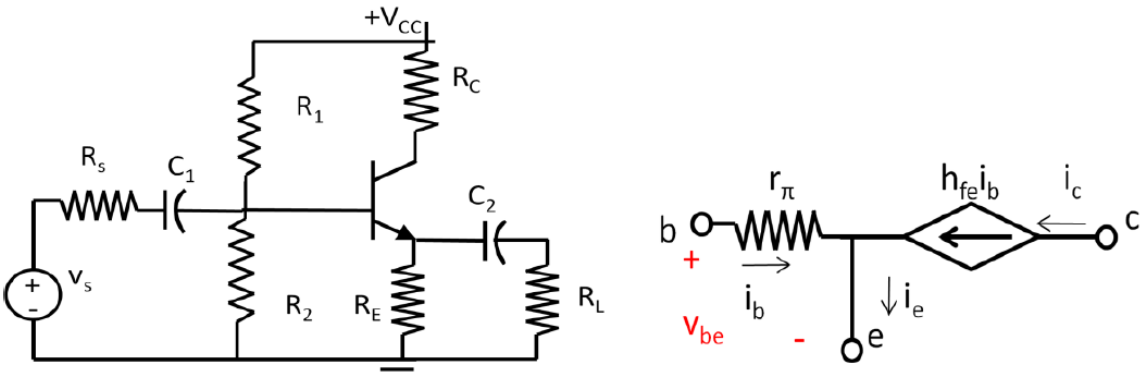
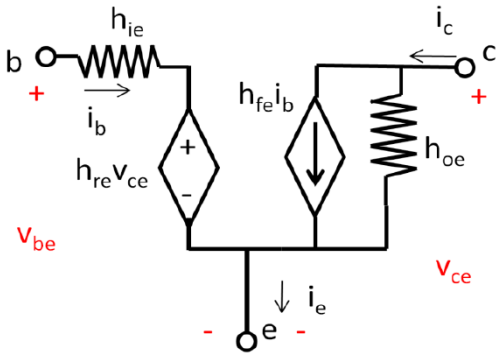
EE 101 Tutorial 8: BJT Amplifiers and Op-Amp circuits

1. A common collector amplifier (emitter follower) is shown below where $R_T=R_E||R_L$. Using the given small signal ac model of the npn BJT, find the voltage gain A_v, input resistance R_{in} and output resistance R_o.

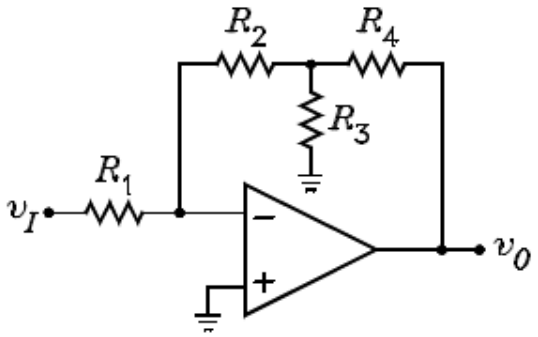


2. For the amplifier above, $h_{fe}=h_{FE}=100$, $R_1=R_2=400$ kΩ, $R_E=R_s=1$kΩ, $R_L=9$ kΩ, and $V_{CC}=20$V. Given that $I_{CQ}=3.09$ mA, find (a) A_v, (b) R_{in}, (c) $A_i=i_L/i_b$, (d) R_o. Does this amplifier act as a unity gain amplifier with high input resistance and low output resistance?

3. A more accurate BJT small signal ac model, the hybrid (h) parameter model is given below. Using this model, find A_v, R_{in} and A_i for the common collector amplifier given above, for $h_{ie}=840$ Ω, $h_{re}=10^{-4}$, $h_{fe}=100$, $h_{oe}=10^{-5}$ Ω^{-1}. Compare the values with those obtained in (2) above.

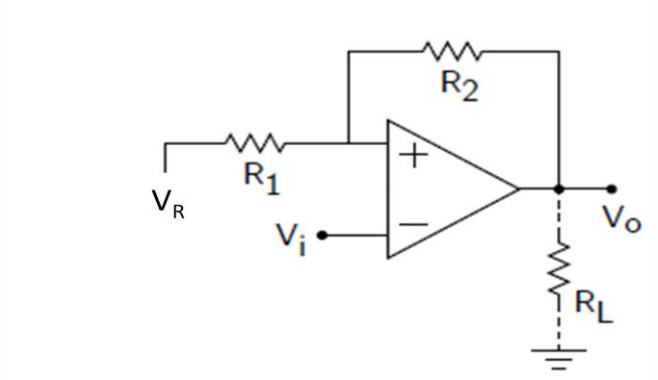


4. Consider the op-amp circuit below operating in the linear mode. Assuming ideal conditions find the voltage gain (v_o/v_I), output resistance and input resistance of this circuit.



5. Design a non-inverting amplifier which has an input resistance of 10 kΩ, an open-circuit voltage gain of 26 dB. The feedback network is specified to draw no more than 0.1mA from the output of the op amp when the open-circuit output voltage is in the range $-10V<v_O<10V$.

6. Consider the following Schmitt trigger circuit. Assume V_o=+/- V_{sat}, plot the V_o vs V_i characteristic, and find the threshold voltages in terms of R_1, R_2 and V_{sat}.



7. The op-amp circuit below is an example of series-series feedback.

(i) Assuming infinite A, R_{in}=∞, R_o=0 Ω for the op-amp, find the gain A_F of the amplifier?

(ii) Assume finite gain A, finite R_{in}, R_o=0 Ω for the op-amp. For R_{in}>>R show that the input resistance R_{iF} of the amplifier is given by, $R_{iF} = \frac{v_{in}}{i_{in}} \approx \left(1 + \frac{AR}{R+R_L}\right) R_{in}$.

(iii) Assume finite gain A, finite R_{in}, non-zero $R_o$for the op-amp. For R_{in}>>R show that, $R_{oF} \approx (1 + A)R + R_o$.