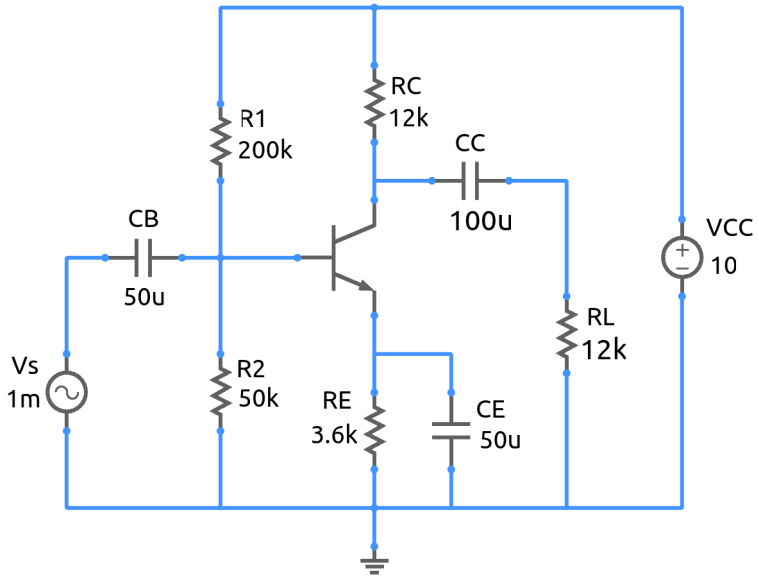
bjt_ce_amp.sqproj



Shown in the figure is a common-emitter amplfier. We are interested in computing the mid-band gain of the amplifier. Assume that the BJT is working in the active mode.

Exercise Set

1. Calculate the bias voltage V_B by ignoring the base current.
2. Using the above value of V_B, find V_E and I_E.
3. Assuming $I_C \approx I_E$, find g_m and r_π. (Take $\beta = 120$ for the r_π calculation).
4. Compute the gain v_o/v_s, input resistance R_i, and output resistance R_o in the mid-band region.
5. Verify your results with simulation as follows.
   (a) DC bias point: Use solve block 1.
   (b) Mid-band gain and frequency response: Use solve block 2. Plot v_o versus frequency (log-log plot). From this plot, the mid-band region can be identified.

(c) Time-domain variation of the collector voltage: Use solve block 3. The frequency is set in the mid-band region here. Verify that $v_C(t)$ observed in the simulation plot is $v_C(t) = V_C + A_V\, v_s(t)\,,$
where V_C is the collector bias voltage, A_V is the mid-band voltage gain, and $v_s(t)$ is the input voltage.

(d) Input resistance: Use solve block 2. Find the source current i_s in the mid-bad region. R_i is then given by $|v_s|/|i_s|$.

(e) Output resistance: Use solve block 5. Here, the frequency is set in the mid-band region, and the load resistance R_L is varied. When R_L is large, the amplifier gain corresponds to the open-circuit (no-load) gain. When R_L is made smaller, the gain drops. The gain becomes half of its open-circuit value when R_L is equal to R_o of the amplifier. By plotting $|v_o|$ versus R_L, R_o can be estimated.

(f) Distortion: Use solve block 3. Increase the source voltage amplitude from 1 mV to 10 mV. Observe that the output voltage is distorted. What is the reason behind this distortion?

6. Change the coupling and bypass capacitance values (one at a time), and see how it affects the frequency response of the amplifier.

7. Change the BJT parameters `cje` and `cjc` (one at a time) which affect the transistor parasitic capacitances C_π and C_μ, and observe its effect on the amplifier frequency response.

References

1. J. Millman and A. Grabel, *Microelectronics,* McGraw-Hill, 1988.

2. A. S. Sedra, K. C. Smith, and A. .N. Chandorkar, *Microelectronic Circuits*, Oxford University Press, 2004.

3. M.B. Patil, *Basic Electronic Devices and Circuits,* Prentice-Hall India, 2013.