ELEN 118
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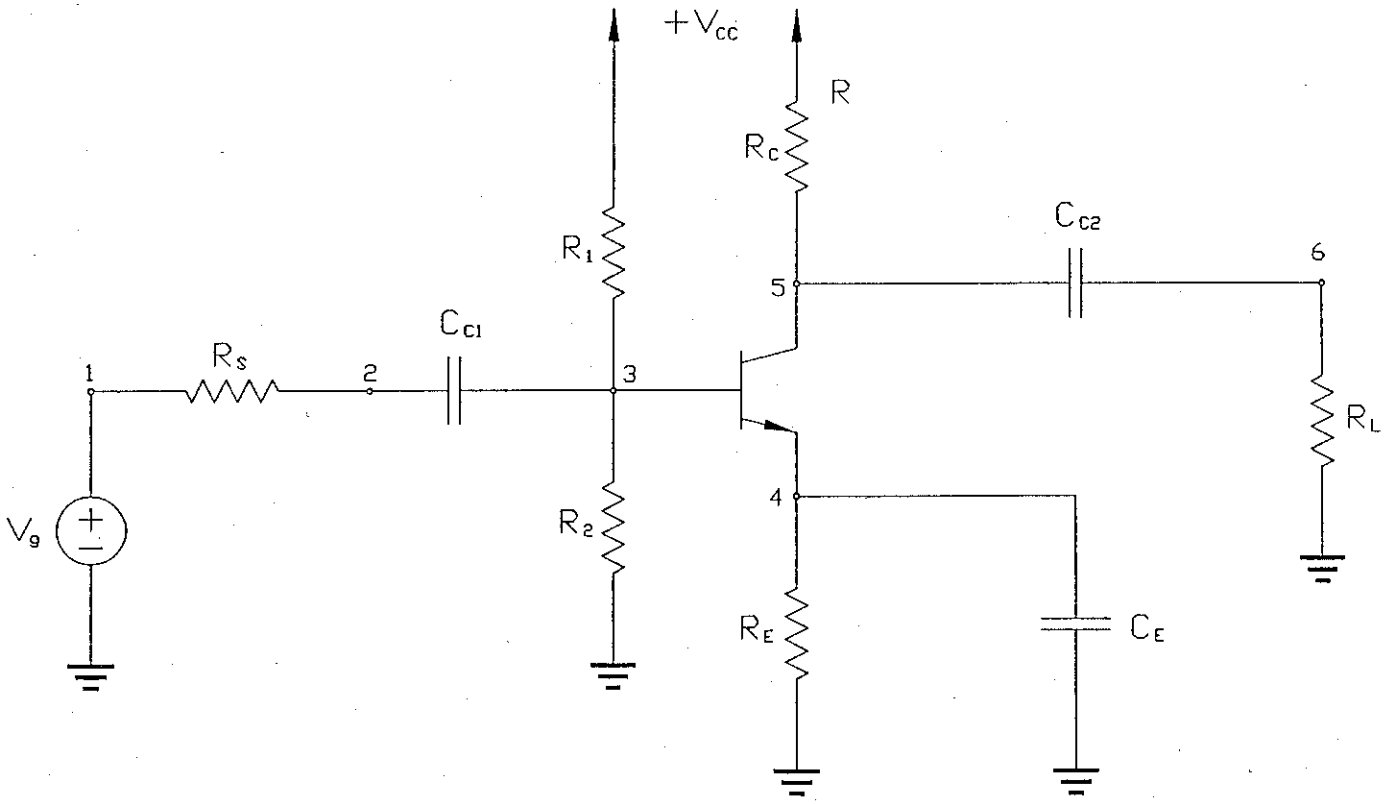
PROJECT # 3: AC Analysis of Linear Amplifiers

The circuit below represents a *common emitter amplifier.*



The element values in this circuit are:

R_S = 4K; R_1 = 8K; R_2 = 4K; R_E = 3.3K; R_C = 6K; R_L = 4K;

$C_{C1} = C_{C2}$ = 1μF; C_E = 10μF and V_{CC} = 12V

and the small signal parameters can be estimated as:

g_m = 38.3 mA/V; r_π = 2.61K; r_0 = 103.5K; C_π = 17pF; C_μ = 2.5pF

PROBLEM 1.

Use the small signal equivalent model to formulate the circuit equations for AC analysis. Indicate matrices *G*, *C* and vector *w* explicitly.

PROBLEM 2.

a) Use the function **[mag, phase] = bode1(*G*, *C*, *w*, *z*)** developed in Project # 2 to compute the complex voltages in the circuit, for frequencies between 10 Hz and 10 MHz (use ten point per decade).

b) Obtain a plot for the magnitude of voltage $\mathbf{V_6}$ (in decibels). Based on this plot, estimate the range of frequencies for which the amplifier has a constant gain (*i. e.* the *mid-frequency range*).

PROBLEM 3.

a) Perform an AC analysis of the common emitter circuit in SPICE. Print out your *input file*.

b) Obtain a magnitude plot for voltage $\mathbf{V_6}$ in SPICE, for the same frequencies as in Problem 2.

c) Compare the results of your program with those of SPICE.

Note: SPICE will compute its own small signal model for the transistor, so parameters g_m, r_π, r_0, C_π and C_μ needn't be specified.

PROBLEM 4.

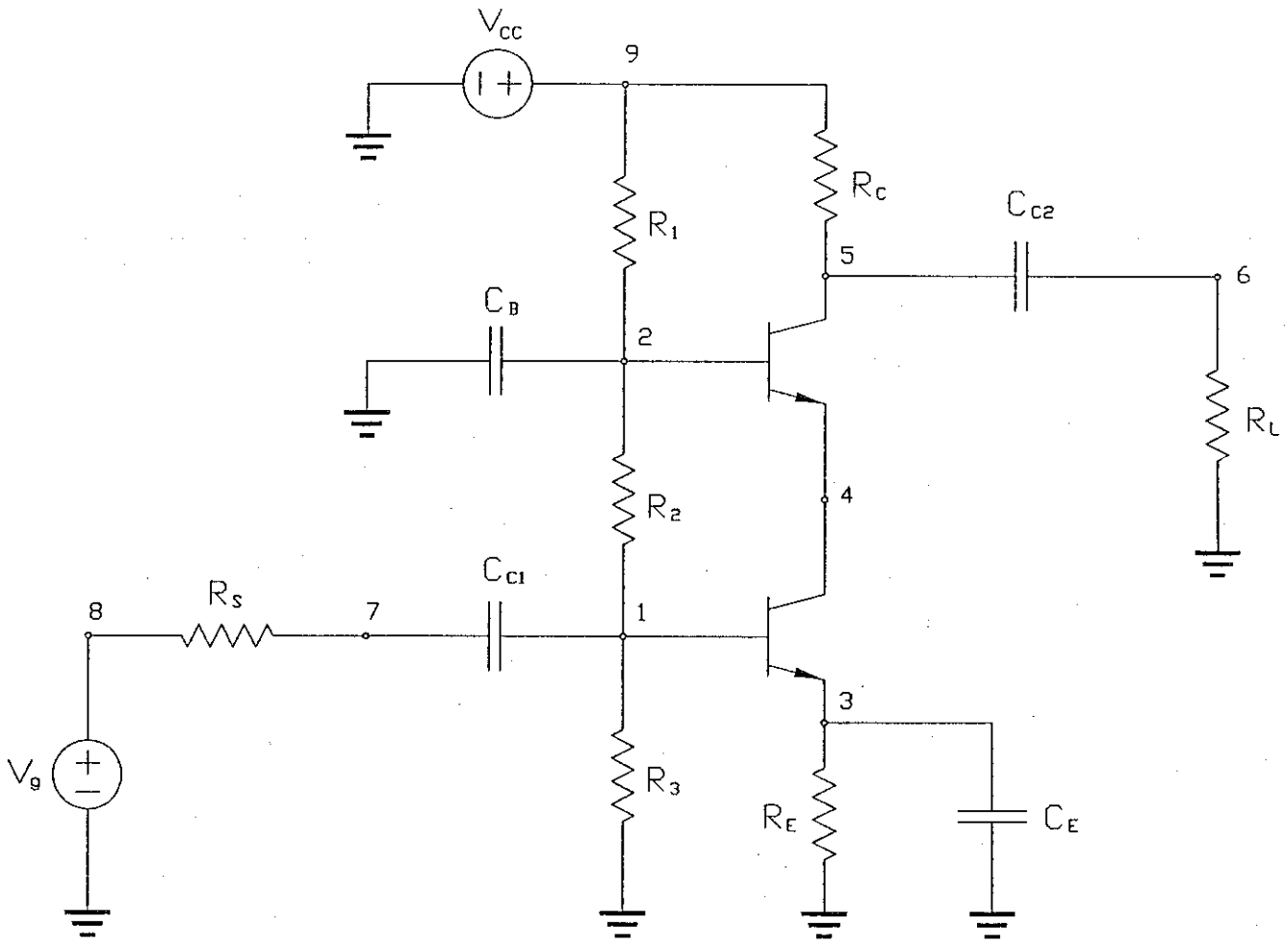
In designing an amplifier, it is desirable to extend the mid-frequency range as much as possible. A circuit that is capable of doing so is the *cascode amplifier* shown on page 3. The element values in this circuit are:

R_S = 4K; R_1 = 18K; R_2 = 4K; R_3 = 8K; R_E = 3.3K; R_C = 6K; R_L = 4K;

$C_{C1} = C_{C2}$ = 1μF; $C_E = C_B$ = 10μF and V_{CC} = 15V

and the small signal parameters can be estimated as:

g_m = 37.1 mA/V; r_π = 2.69K; r_0 = 106.9K; C_π = 17pF; C_μ = 2.5pF



a) Repeat Problems 1, 2 and 3 for this circuit.

b) Based on your results, compare the frequency characteristics of a *common emitter* and a *cascode amplifier*. Which one performs better? Explain.