MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Electrical Engineering and Computer Science

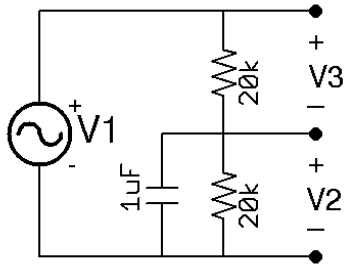
6.301 Solid State Circuits

Fall 2013 — Issued : Sept 5, 2013

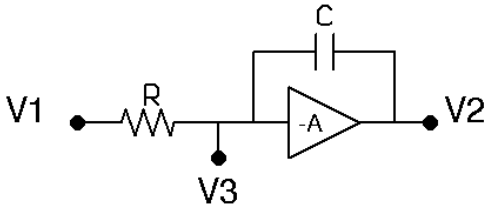
Problem Set 1 — Due : Sept 12, 2013

Problem 1: Basic Techniques

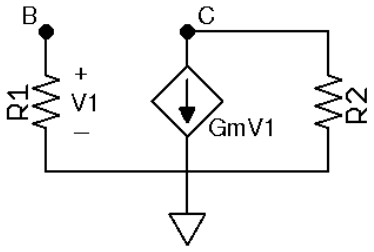
(a) For the following circuit, sketch the pole-zero plot, Bode plot, and unit step response for $\frac{V_2}{V_1}(s)$ and $\frac{V_3}{V_1}(s)$.

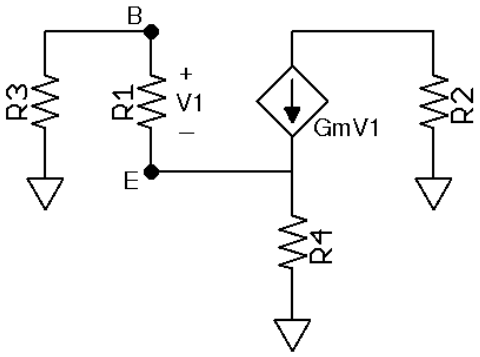


(b) Find the transfer functions $\frac{V_2}{V_1}(s)$ and $\frac{V_3}{V_1}(s)$ for the following circuit.
What is the impedance looking into node V_3? What effect does the amplifier have on the capacitor?



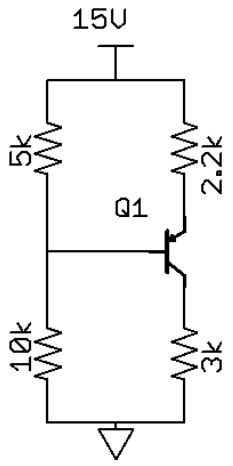
(c) Find the Thevenin resistances R_{BC} and R_{BE} for the following circuits.





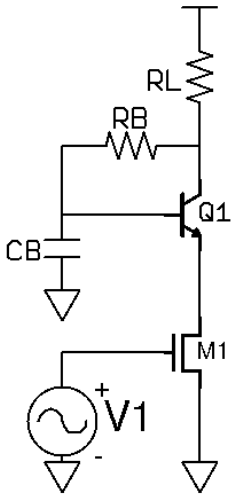
Problem 2: Transistor parameter hunting

Consider the following circuit, where $V_{be} = 0.6V$, $\beta = 200$, and $V_A = 80$. Find I_S for the large signal model and find g_m, r_π, and r_o for the hybrid-pi small-signal model. Draw the small-signal equivalent circuit.



Problem 3: Biasing

Consider the following circuit, where for
Q1: $I_S = 10^{-15}A$, $V_A = \infty$, $V_{CE_{sat}} = 0.2V$, $\beta = 200$,
M1: $V_T = 0.6V$, $\mu_n C_{ox} \frac{W}{L} = 200 \frac{\mu A}{V^2}$, $\lambda = 0$ $V_{cc} = 5V$,$R_L = 30k$,C_B is large.



(a) Determine the DC value of V1 such that $I_{C1} = 60\mu A$.

(b) Find the DC output voltage at the collector of Q1.

(c) Determine the range of R_B that keeps M1 in saturation and Q1 in the FAR.