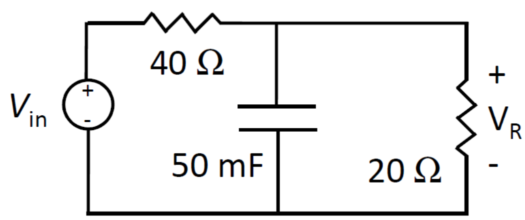
ECE 202: Linear Circuit Analysis II – Fall2013

HOMEWORK SET 4: DUE TUESDAY, SEPTEMBER 10, 5 PM IN MSEE 180

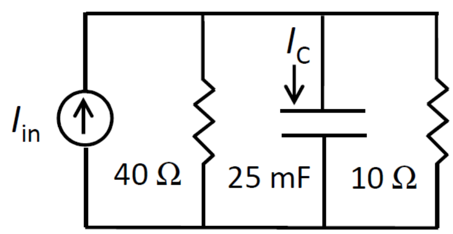
ALWAYS CHECK THE ERRATA on the web.

Main Topics: Equivalent circuits for L and C with initial conditions; transfer functions; H(s).
Suggestion: Do what you can by hand, but ALWAYS check in MATLAB, or use MATLAB and then do by hand to practice for Exam 1.

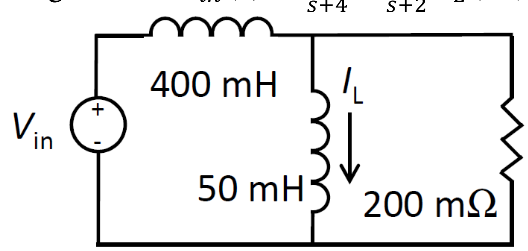
13. For each of the circuits below, find (i) the zero-input response (due only to the initial condition(s)), (ii) the zero-state response (due only to the input when the ICs are zero), and (iii) the complete response.
(a) Find $v_R(t)$, given that $v_{in}(t) = 3te^{-2t}u(t)$ and $v_C(0^-) = -12$ V (i.e., the top of the capacitor is initially 12 V lower potential than the bottom).



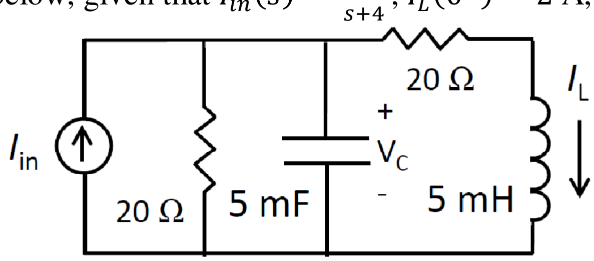
(b) Find $I_C(t)$ for the circuit below, given that$I_{in}(s) = \frac{6}{s^2+2s}$ and$v_C(0^-) = 18$V (i.e., the top of the capacitor is initially 18 V higher potential than the bottom).



14. For each of the circuits below, find (i) the zero-input response (due only to the initial condition(s)), (ii) the zero-state response (due only to the input when the ICs are zero), and (iii) the complete response.
(a) Find $I_L(s)$ for the circuit below, given that $V_{in}(s) = \frac{4}{s+4} - \frac{2}{s+2}$, $I_L(0^-) = -4$ A, and $V_R(0^-) = 0$.

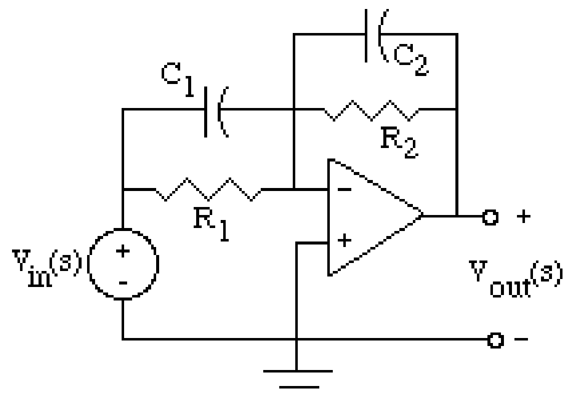


(b) Find $I_L(s)$ for the circuit below, given that $I_{in}(s) = \frac{7s+3}{s+4}$, $I_L(0^-) = 2$ A, and $V_c(0^-) = 1$ V.

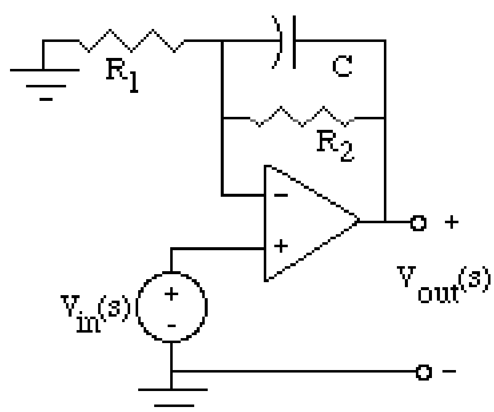


15. Compute the indicated transfer function $H(s)$ for each of the circuits below. Then find the indicated response.

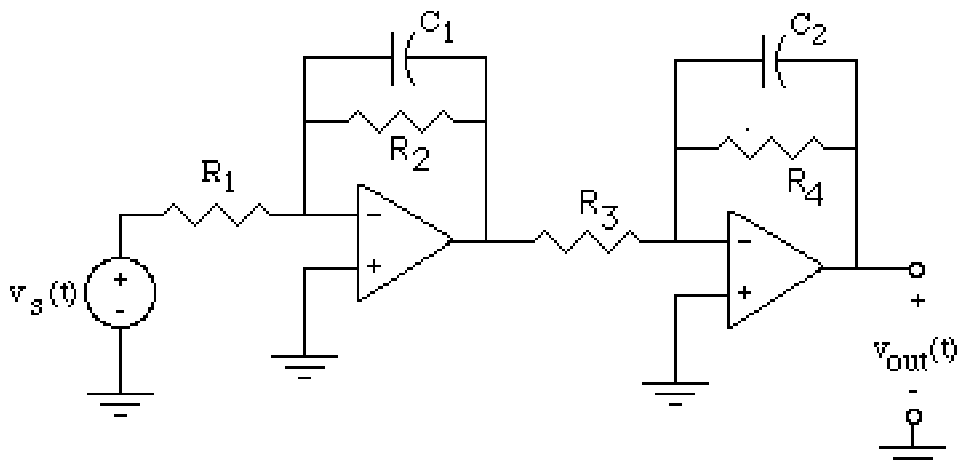
(a) For the circuit below, find $H(s) = \frac{??s + ??}{s + ??}$ in terms of $C_1, C_2, G_1 = 1/R_1$, and $G_2 = 1/R_2$ (assuming both capacitors initially have zero voltage). If $C_2 = 0.2$ F, find the value of R_2 (in Ω) for which the transfer function $H(s) = -\frac{2s+2}{s+5}$. Finally, determine the step response (the response due to a step function input with zero initial conditions) for the given transfer function. **Check**: $1 \leq R_2 \leq 10\Omega$.



(b) In the circuit below, suppose $C = 0.1$ F, $R_2 = 10\ \Omega$, and $R_1 = 5\ \Omega$. Find the transfer function of the op amp circuit $H(s)$, and then determine the response to the input $V_{in}(t) = 6te^{-3t}u(t) + 3e^{-t}u(t)$V, assuming zero initial conditions. Check: $H(s) = \frac{??}{s+1}$.



16. **(a)** In the circuit below $C_1 = C_2 = 1$ mF and $R_1 = R_3 = 1\,\text{k}\Omega$. If the transfer function $H(s) = \frac{V_{out}(s)}{V_s(s)} = H_1(s)H_2(s) = \frac{-1}{s+4} \times \frac{-1}{s+2}$. We assume that $H_1(s) = \frac{-1}{s+4}$ corresponds to the first stage (first op amp circuit). Find the necessary values for R_2 and R_4 (in Ω) respectively. Then determine the impulse and step responses. The impulse response is the response due to an impulse function input assuming zero initial conditions; the step response is the response to a step function input assuming zero initial conditions.



(b) Compute $H_1(s) = \frac{V_1(s)}{V_{in}(s)}$, $H_2(s) = \frac{V_{out}(s)}{V_1(s)}$, and $H(s) = H_1(s)H_2(s) = \frac{V_{out}(s)}{V_{in}(s)}$ assuming that C_1=20 mF, R_1=40 Ω, C_2=10 mF, R_2 =1 kΩ, R_3=500 Ω, C_3=5 mF, C_4=2 mF, and R_4=2 kΩ. The point here is to solve two simple problems before solving the more complex problem of finding the transfer function of the cascaded network. After finding the transfer function compute the impulse and step responses.