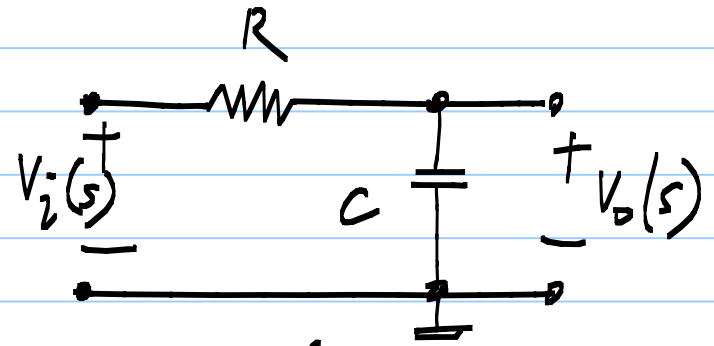
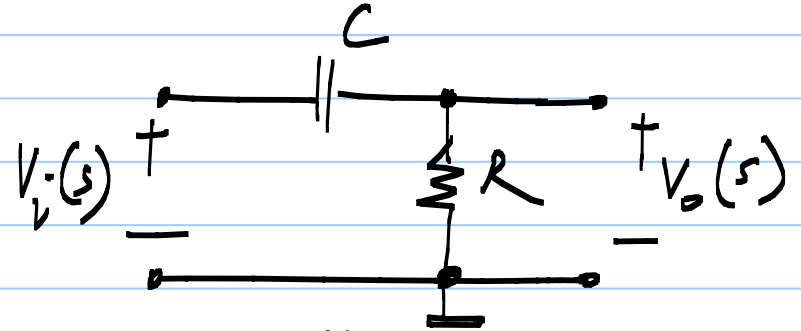
Laplace transform calculations-practice problems; Nagendra Krishnapura, 17 Aug. 2011

Note Title 8/16/2011

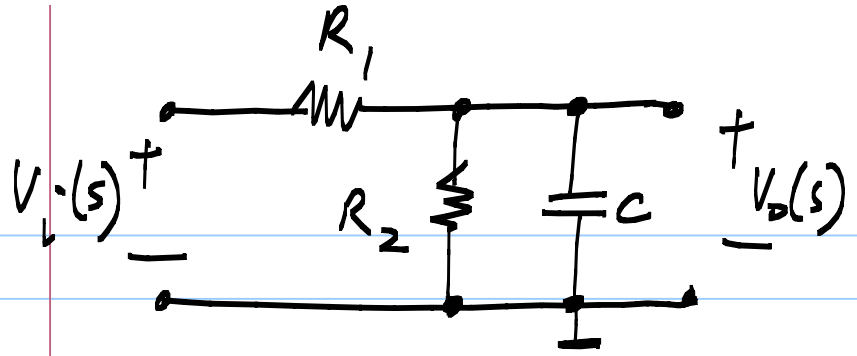
(1) Evaluate $V_o(s)/V_i(s)$ for the circuits below by replacing frequency dependent components by their Laplace impedances. Arrange the answers in the form $\frac{b_0 + b_1 s + \ldots}{a_0 + a_1 s + \ldots}$ where b_0 and a_0 are dimensionless constants.



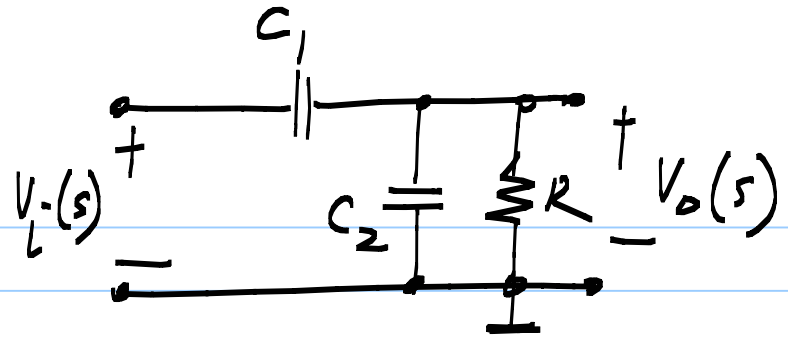
(a)



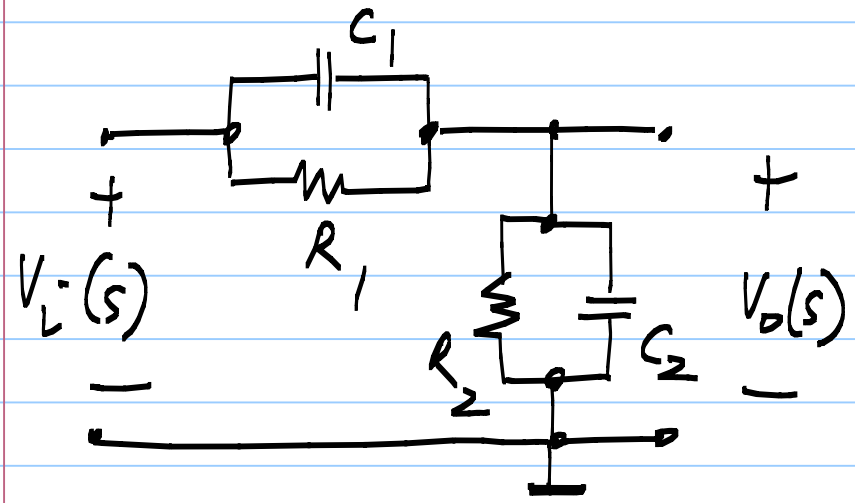
(b)



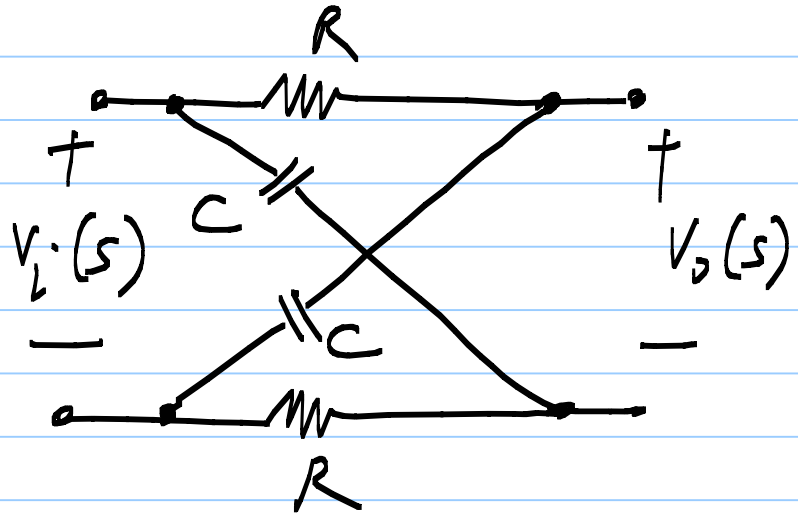
(c)



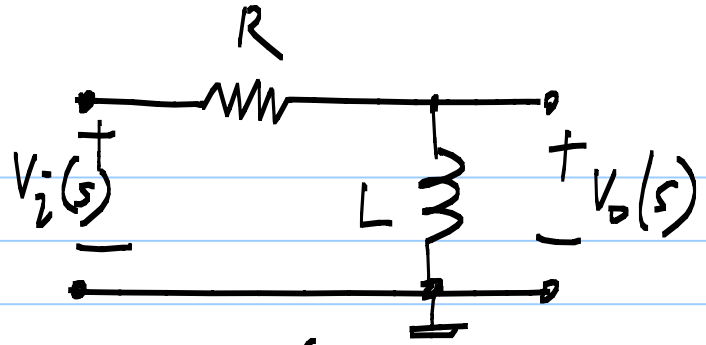
(d)



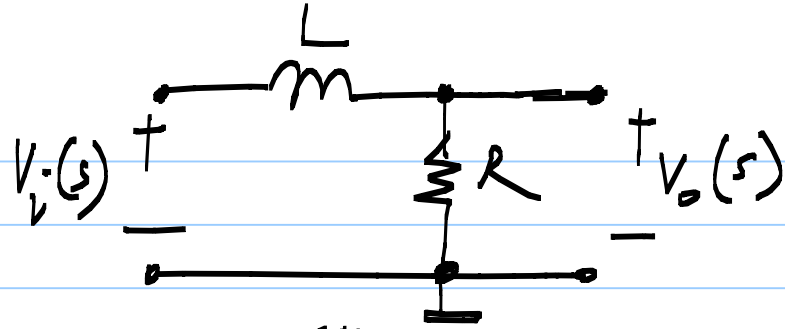
(e)



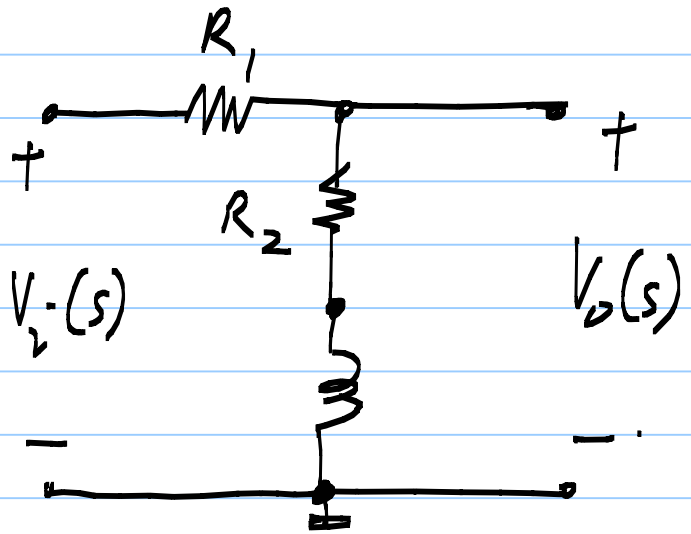
(f)



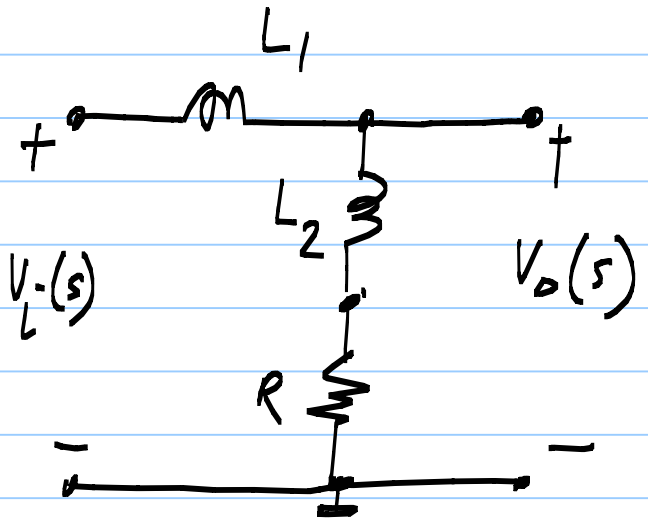
(g)



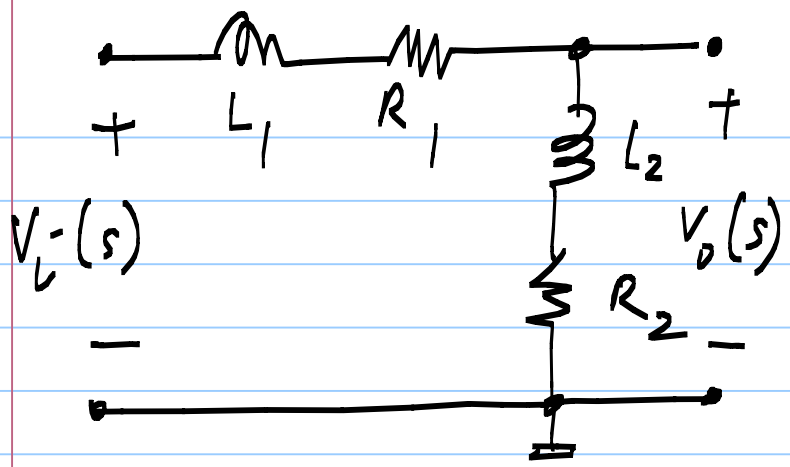
(h)



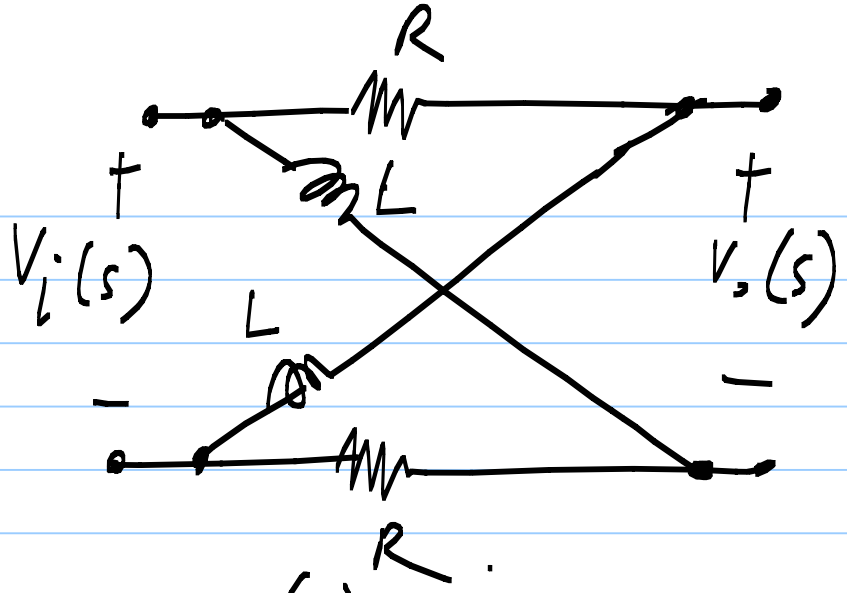
(i)



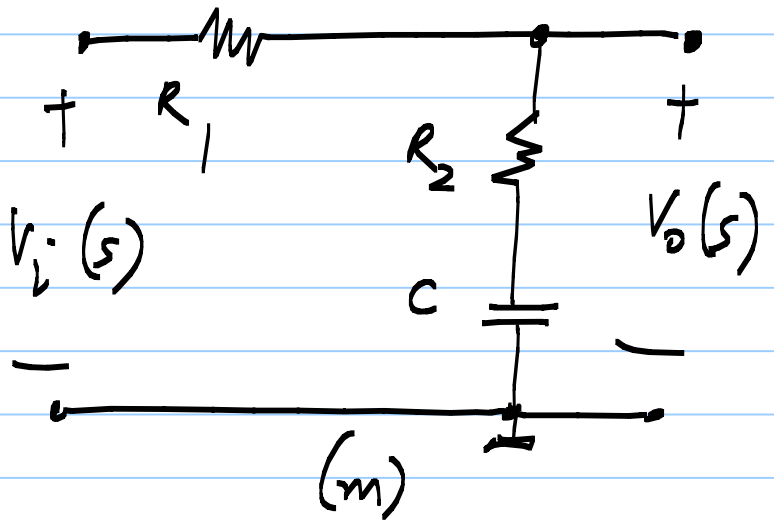
(j)



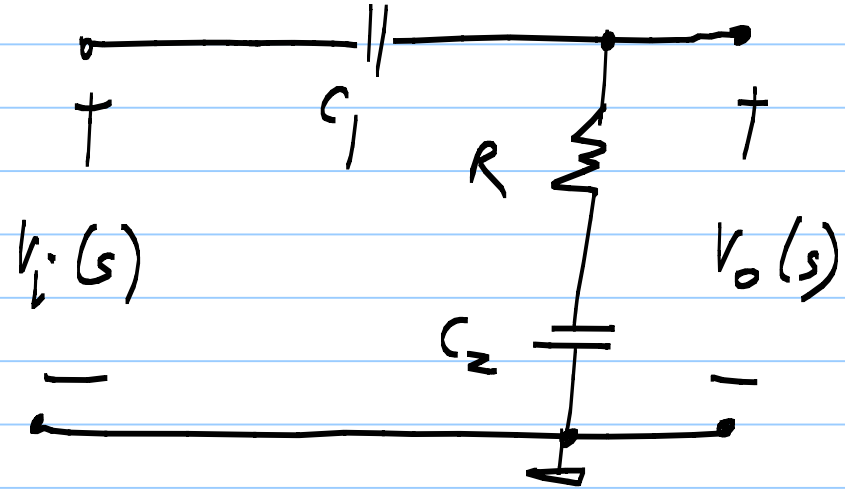
(k)



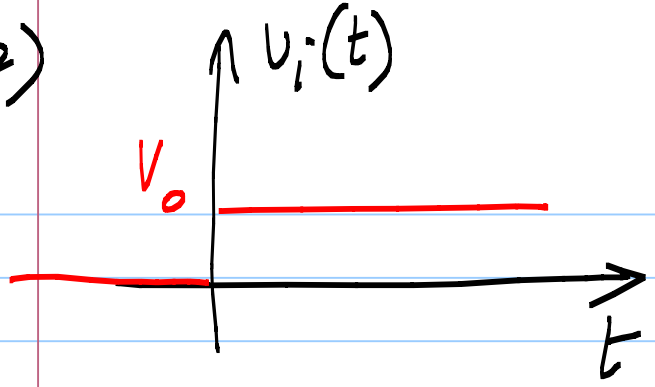
(l)

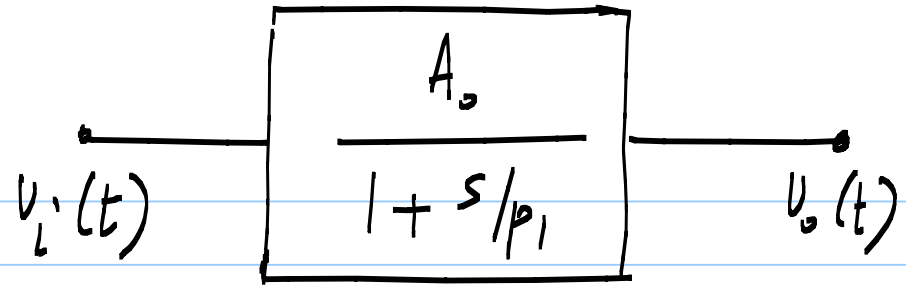


(m)



(2)



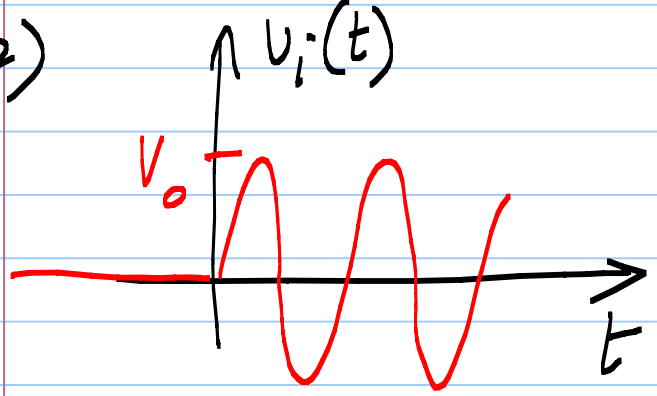


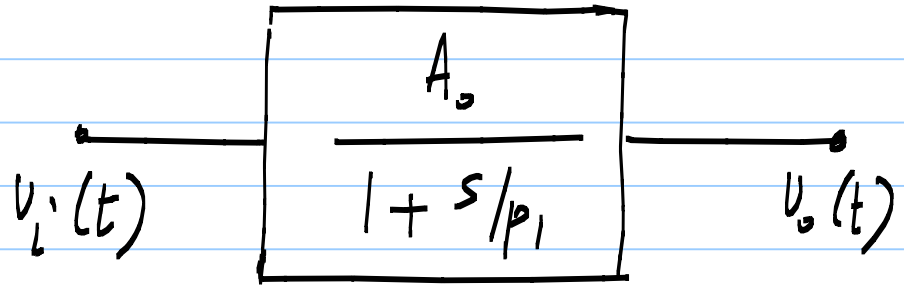
A step of V_o volts at $t=0$ is applied to the system above. Evaluate the complete (transient and steady state) output using Laplace transform analysis. Separate the output (in Laplace domain as well as time domain) into a part containing a step and a part containing the rest.

(cont'd)

What happens to these two parts over time?

(2)



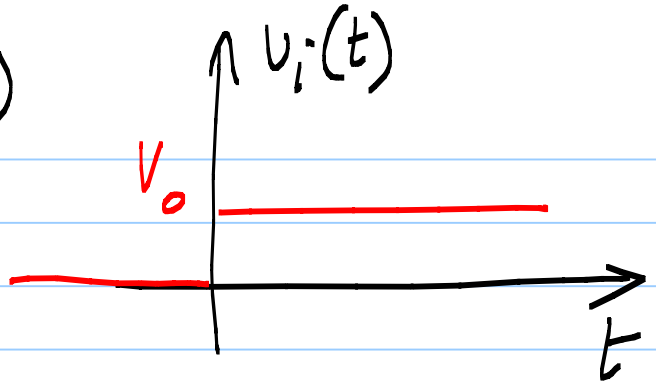


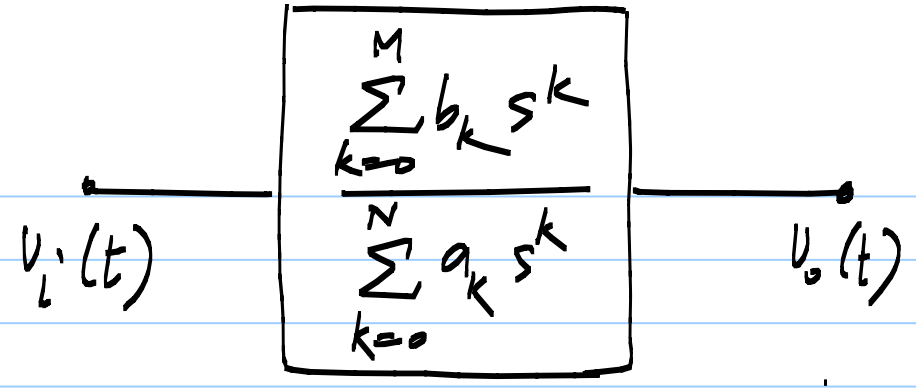
A sinusoid of amplitude V_o volts is applied to the system above. Evaluate the complete (transient and steady state) output using Laplace transform analysis. Separate the output (in Laplace domain

as well as time domain) into a part containing the sinusoid a part containing the rest. What happens to these two parts over time?

(3) Repeat the above problem with a cosine instead of a sine.

(4)





A step of V_o volts at $t=0$ is applied to the system above. Evaluate the complete (transient and steady state) output in Laplace domain. Separate the output into two parts, one containing a step and another containing the rest.

What happens to the two parts over time? (Assume a stable filter).

(5) Plot the magnitude and phase of the sinusoidal steady state response (Bode plots) of the circuits in problem #1.

(6) What happens to the circuits of problem #1 at very low and very high frequencies? Evaluate the transfer function of these reduced circuits and reconcile them with answers to p #5.

(7) Evaluate the poles and zeros of the transfer functions in P#1.

(8) Relate the values of the poles above to the components in the circuit with zero input.

[By practicing enough of 6 & 8, you should be able to write down many transfer functions by inspection].

(g) Estimating zeros by inspection is harder. Set the output to zero (not by shorting the output; just imagine that for some $s = z_1$, $V_o(s) = 0$), write the circuit equations and determine z_1 for which this is true in the circuits in P#1.

(10) Just so that you get used to a current input, do 1, 5, 6, 7, 8 with the circuits below.