ECE 307 - LAPLACE TRANSFORM - INVESTIGATION 17
TRANSFER FUNCTIONS OF BILATERAL LAPLACE TRANSFORMED CIRCUITS

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To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

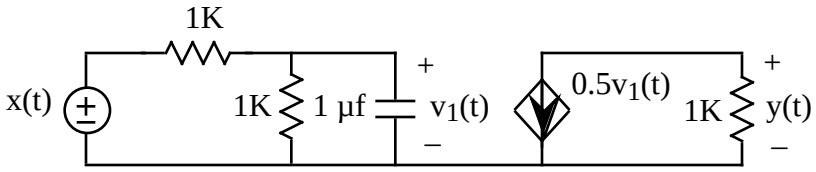
The objective of this investigation is to get practice analyzing and finding the transfer functions of bilateral LaPlace Transfomed circuits.

1. How would you expect the transfer function G(s) of a Bilateral LaPlace Transformed circuit with input x(t) and output y(t) to be defined. How are transfer functions G(s) similar to frequency responses G(jω).

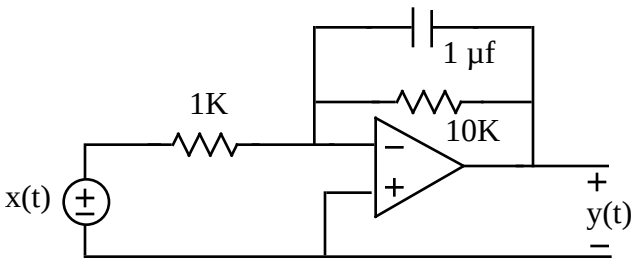
2. How are transfer functions G(s) useful.

3. Find the transfer functions G(s) = Y(s)/X(s) of the following circuits

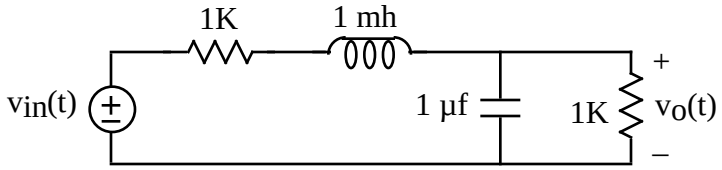
   a.



   b.



4. Find the transfer function $G(s) = V_O(s)/V_{in}(s)$ of the following circuit



5. Find the zero state response of a circuit with the following transfer function

$$G(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{10^6}{s^2 + 1000s + 1.5x10^5}$$

   to the input $v_{in}(t) = 5\,u(t)$

6. Make use of the fact that Y(s) = G(s)X(s) to find the LaPlace Transform of a circuit's impulse response h(t) as given by

$$L[\text{Impulse Response}] = L[h(t)] = \int_{-\infty}^{\infty} h(t)e^{-st}dt$$

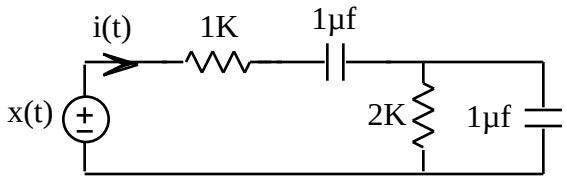
as a function of the circuit's transfer function G(s). **Memorize** your result.

7. Find the LaPlace Transform of a circuit's step response s(t) as given by

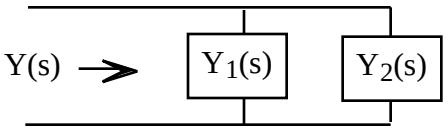
$$L[\text{Step Response}] = L[s(t)] = \int_{-\infty}^{\infty} s(t)e^{-st}dt$$

as a function of the circuit's transfer function G(s). **Memorize** your result.

8. Find the input impedance Z(s) = V(s)/I(s) and the input admittance Y(s) = 1/Z(s) of the following circuit



9. Derive the expression for the admittance Y(s) of the following circuit



in terms of $Y_1(s)$ and $Y_2(s)$

10. Find a circuit with
    a. Input impedance $Z(s) = 10^3 + 10^{-3}s$
    b. Input admittance $Y(s) = 10^{-3} + 10^{-5}s$

11. How can the frequency response of a circuit as follows $G(j\omega) = V_o(j\omega)/V_{in}$ be obtained from its transfer function G(s). **Memorize** the relationship between G(s) for Bilateral LaPlace Transformed circuit and G(jω) for the corresponding phasor circuit.

12. Find the sinusoidal steady state response of a circuit with transfer function

$$G(s) = \frac{Y(s)}{X(s)} = \frac{10^6}{s^2 + 1000s + 1.5x10^5}$$

to x(t) = 5 cos (500t)