Chemistry 243 Winter Quarter 2017.
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Problem Set #2

A. Operational Amplifiers

1. Take the three problem "Op Amp Quiz."
http://unicorn.ps.uci.edu/243/psets/OpAmps.pdf

2. Explain what a current follower is and how it is used in PMT and photodiode circuits.

B. LaPlace transforms

3. Use LaPlace transforms to solve the following differential equations:

a. Fluorescence Decay:

$$\frac{dC}{dt} = -\Gamma C$$

with the initial conditions $C(0) = C_0$.

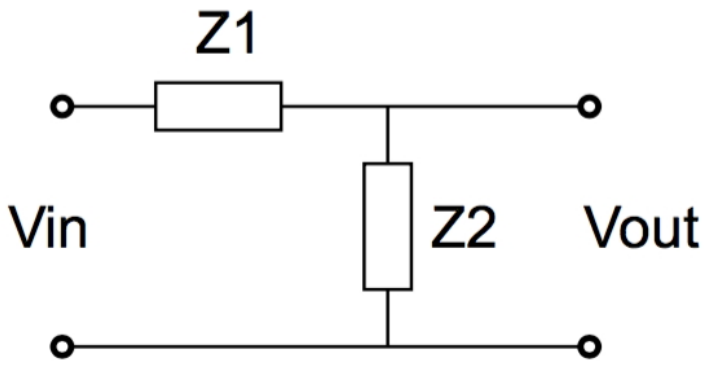
b. Damped Harmonic Oscillator:

$$m\frac{d^2x}{dt^2} + 2m\Gamma\frac{dx}{dt} + m\omega^2 x = 0$$

with the initial conditions $x(0) = X_0$ and $x'(0) = 0$. What are the equations when $\omega = \Gamma$?

C. Frequency Analysis: Nyquist and Bode Plots

4. Use LaPlace Transform Analysis to make a Nyquist Impedance Plot and Bode Impedance plots (both magnitude and phase) for an angular frequency range of 10^{-2} rad s^{-1} to 10^8 rad s^{-1} for these two RC circuits:



Circuit 1: Z1 = R, Z2= C

Circuit 2 Z1 = C, Z2 = R

Where R = 1000 ohms and C = 2.0 μF.

D. Frequency Domain Fluorescence Measurements.

Frequency domain fluorescence spectroscopy (fdfs) is an alternative method for obtaining fluorescence lifetimes. In these measurement, two parameters: a phase shift angle (phi) and demodulation factor (m), are measured.

5. What is the mathematical relationship between these measured parameters and the fluorescence lifetime (tau)? Can you derive this?