EE 102A - Midterm Exam

Notes, books, and electronics are not permitted on this exam.

You are only required to do three of the following four problems. If you do all four, the top three scores will be used as your grade. Justify all your answers.

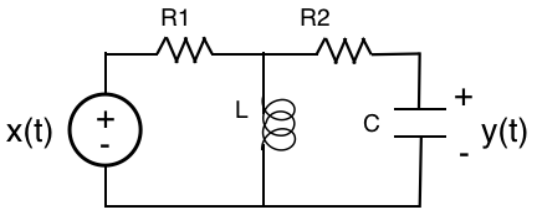
Problem 1. *10 points*
a) Determine whether the following systems are linear or non-linear, shift invariant or shift variant, causal or non-causal, and have memory or are memoryless. Justify all your answers.

$$S\{y(\gamma)\}(t) = \int_{-\infty}^{t} y(\gamma)d\gamma$$

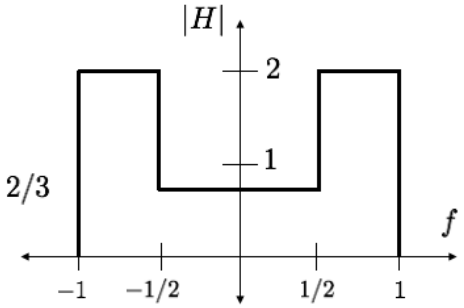
$$S\{y(\gamma+3)\}(t) = y(t+2) - y(t-1)$$

b) Find the systems' impulse responses. (If either system is shift variant, only find the response for the impulse located at 0.)

Problem 2. *10 points*
Find the transfer function of the following system (where x is the input and y is the output).



Problem 3. *10 points*
A system's modulation transfer function is shown below. The phase of the transfer function is 0 for all f; that is, $\angle H(f) = 0$.



Find the output of this system when the input is $g(x) = \text{sinc}(x) + \text{sinc}(2x)$.

Problem 4. *10 points*
Prove the following theorems.
a) The Fourier Transform of a real and even function is real and even.
b) The Fourier Shift Theorem: $\mathcal{F}\{f(x-\Delta)\} = e^{-i2\pi k\Delta}\mathcal{F}\{f\}(k)$.
c) The Fourier Transform of the Dirac Delta function: $\mathcal{F}\{\delta\} = 1$.