5 Labwork

5.1 Fourier Transform

- Plot the signal that is given in (1) where $f_c = 50Hz$. $x_1(t)$ is defined for $t \in [0, 0.5]$ where $F_s = 1000Hz$.

$$x_1(t) = \begin{cases} cos(2\pi f_c t) & 0 \leq t \leq 0.1 \\ 0 & otherwise. \end{cases} \tag{1}$$

- Calculate the Fourier Transform of the signal $x_1(t)$.
  - Create a frequency vector for $F_s = 1000Hz$ which has 1024 elements by using *linspace()*.
  - Use the definition in (2) to calculate Fourier Transform for the frequencies that you obtained above. You can use $dt = 0.001$ when you calculate the integral.

$$X_1(f) = \int_{-\infty}^{\infty} x_1(t) \mathrm{e}^{-j2\pi ft} dt. \tag{2}$$

- Calculate the Fourier transform of $x_1(t)$ given in (1) with $fft()$ command for $N = 1024$ points with the sampling frequency $F_s = 1000Hz$. (**Hint:** *Normalize* $|X_1(f)|$ *by dividing* $|X_1(f)|$ *to* N.)
- Plot the magnitudes of $X_1(f)$ which is calculated with two different methods above in the same figure window by using *subplot*() command. Show that you obtained the same frequency spectrum in both plots. Note that both two frequency responses are plotted with respect to the same frequency vector that you obtained before by using *linspace()*. (**Hint:** Frequency response must be symetric with respect to origin in frequency axis. Use *fftshift()*)

5.2 Obtaining the System Impulse Response via Fourier Transform

- Assume that for a given input $x_2(t)$, we observe an output $y(t)$ which is given in Figure 1. This system has an impulse response of $h(t)$. Find this impulse response by using *fft()* and *ifft()*. Follow the steps that are given below:
  - Derive the mathematical expressions for $x_2(t)$ and $y(t)$.
  - Obtain time vector $t = 0 : T_s : d$ where $d = 0.5s$ and $T_s = 0.001s$.
  - Obtain $x_2(t)$ and $y(t)$ with respect to the time vector.
  - Find $X_2(f)$ and $Y(f)$ by using *fft()*. Use FFT size $N = length(t)$.
  - Obtain $H(f)$ by applying necessary operation to $X_2(f)$ and $Y(f)$.
  - Obtain $h(t)$ by using *ifft()*.
  - Plot the system impulse response, input and output in one figure by using *subplot*().

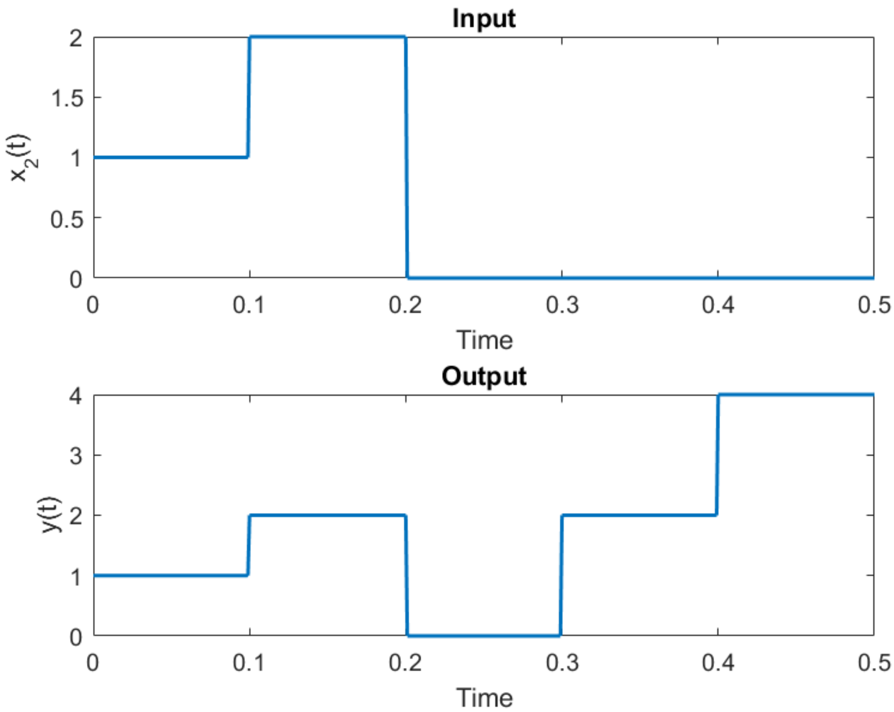

Figure 1: Output and input signals for question 2

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