

ECE 301 (Section 001) Homework 10, Spring 2021

Problem 1 (Windowed Time-Domain Signals) Find and plot the Fourier transform of the following windowed sinusoidal signals.

a)

$$x(t) = \begin{cases} \cos(10t), & -10 \leq t \leq 10. \\ 0, & \text{elsewhere.} \end{cases}$$

b)

$$x(t) = \begin{cases} \cos(10t), & 0 \leq t \leq 10. \\ 0, & \text{elsewhere.} \end{cases}$$

Hint: Use the multiplicative property of the Fourier transform.

Problem 2 (Lowpass Filter) A lowpass filter $H(\omega)$ has the frequency response shown in Figure 1.

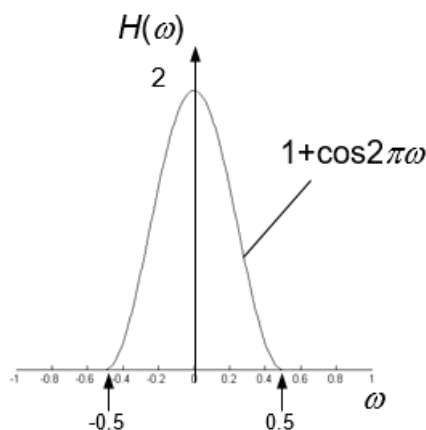


Figure 1: Frequency response of the lowpass filter $H(\omega)$.

a) Compute the impulse response $h(t)$ of the filter.

b) Compute the response $y(t)$ when the input is $x(t) = \text{sinc}\left(\frac{t}{2\pi}\right)$, $-\infty < t < \infty$.

c) Compute the response $y(t)$ when $x(t) = \text{sinc}\left(\frac{t}{4\pi}\right)$, $-\infty < t < \infty$.

Note: Refer to version 2 of Lecture 18 slides for the Fourier table.

Problem 3 (5', compulsory) (Computational Complexity in Time Domain vs. in Frequency Domain) In class, you've seen that calculating the convolution between two time-domain sinc functions in the frequency domain can significantly lower the computation cost. Argue under what scenario time-domain calculation can significantly lower the computation cost. Give a concrete example in terms of two signals.

Group Study (1', bonus) Take a screenshot of the whole team with everyone's camera capturing his/her face. One of you will share a window showing the specific homework assignment sheet that you are working on. Include the screenshot in your own homework submission as Problem 4. Your screenshot gets you 1 bonus point; your group members need to do it separately to earn theirs.