Name _____ ID3 _ _ _

EES 351: Principles of Communications **2020/1**

HW 5 — Due: Not Due

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Problem 1. [1]

(a) Consider the cosine pulse

$$p(t) = \begin{cases} \cos(10\pi t), & -1 \le t \le 1 \\ 0, & \text{otherwise} \end{cases}$$

(i) Sketch $p(t)$ for $-3 \le t \le 3$.

(ii) Find $P(f)$ analytically.

(iii) Sketch $P(f)$ from -10 Hz to 10 Hz.

[1] Inspired by [Carlson and Crilly, 2009, Q2.2-1 and Q2.2-2].

(b) Consider the cosine pulse

$$p(t) = \begin{cases} \cos(10\pi t), & 2 \le t \le 4 \\ 0, & \text{otherwise} \end{cases}$$

(i) Find $P(f)$ analytically.

(ii) Use `MATLAB`. Mimic the code in `specrect.m` to plot the spectrum of $p(t)$. Follow the settings below:

- Consider the time t from 0 to 10 [s] when you set up the time vector.
- Use the sampling frequency of 500 samples per sec. So, the sampling interval (the time between adjacent samples) is $T_s = 1/500$.
- With the above sampling frequency, `plotspect` will plot the magnitude spectrum from -250 to 250 Hz. Use the function `xlim` (or the magnifier glass GUI) to limit your frequency view to be only from -10 to +10 Hz.

(iii) Also in `MATLAB`, add the plot of your analytical answer from part (i) into the same figure as part (ii).

i. Put/paste your plots in the provided space on the next page.

ii. Compare the two plots. (Write some description/observation. Are they the same? How can you tell?)

Caution: The built-in `sinc` function in `MATLAB` is defined using the normalized version. So, you will need to remove a factor of π from the argument of each sinc function found in part (i) when you type it into `MATLAB`.

Problem 2. You are given the baseband signals (i) $m(t) = \cos 1000\pi t$; (ii) $m(t) = 2\cos 1000\pi t + \cos 2000\pi t$; (iii) $m(t) = (\cos 1000\pi t) \times (\cos 3000\pi t)$. For each one, do the following.

(a) Sketch the spectrum of $m(t)$.

(b) Sketch the spectrum of the DSB-SC signal $m(t)\cos(10,000\pi t)$.

[Lathi and Ding, 2009, Q4.2-1]

Problem 3. Given a system with input-output relationship of

$$y(t) = 2x(t) + 10,$$

is this system linear? [Carlson and Crilly, 2009, Q2.3-10]

Problem 4. Signal $x(t) = 10\cos(2\pi \times 7 \times 10^6 \times t)$ is transmitted to some destination. The received signal is $y(t) = 10\cos(2\pi \times 7 \times 10^6 \times t - \pi/6)$.

(a) What is the minimum distance between the source and destination?

(b) What are the other possible distances?

[Carlson and Crilly, 2009, Q2.3-14]

Problem 5 (M2011)**.** Use properties of Fourier transform to evaluate the following integrals. (Do not integrate directly. Recall that $\text{sinc}(x) = \frac{\sin(x)}{x}$.) Clearly state the property or properties that you use.

(a) $\int_{-\infty}^{\infty} \text{sinc}\left(\sqrt{5}x\right)dx$

(b) $\int_{-\infty}^{\infty} \text{sinc}\left(\sqrt{5}x\right)\text{sinc}\left(\sqrt{7}x\right)dx$

(c) (Optional) $\int_{-\infty}^{\infty} e^{-2\pi f\times 2j}2\text{sinc}\left(2\pi f\right)\left(e^{-2\pi f\times 5j}2\text{sinc}\left(2\pi f\right)\right)^{*}df$

(d) (Optional) $\int_{-\infty}^{\infty} \text{sinc}\left(\pi\left(x-5\right)\right)\text{sinc}\left(\pi\left(x-\frac{7}{2}\right)\right)dx$