ECS 332: Principles of Communications **2016/1**

HW 3 — Due: September 16, 5PM

Lecturer: Prapun Suksompong, Ph.D.

Instructions

(a) This assignment has 5 pages.

(b) (1 pt) Write your first name and the last three digit of your student ID on the upper-right corner of ***every*** submitted page.

(c) (1 pt) For each part, write your explanation/derivation and answer in the space provided.

(d) (8 pt) It is important that you try to solve all non-optional problems.

(e) Late submission will be heavily penalized.

Problem 1 (M2011)**.** The Fourier transform $X(f)$ for a signal $x(t)$ is shown in Figure 3.1.

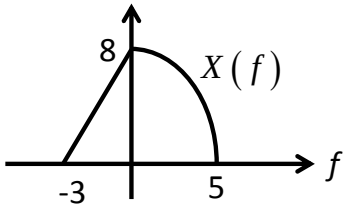

Figure 3.1: Plot of $X(f)$ for Problem 1.

Let $g(t) = x(-2t)$ and $y\,(t) = x\,(4 - 2t)$. Carefully sketch $|G(f)|$ and $|Y(f)|$.

Problem 2. [1]

(a) Consider the cosine pulse

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

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

(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).

- Print this figure and attach it at the end of your HW.
- On this attached page, 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 3. 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 4 (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) $\int_{-\infty}^{\infty} \text{sinc}\left(\pi\left(x-5\right)\right) \text{sinc}\left(\pi\left(x-\frac{7}{2}\right)\right) dx$