

ECE 440 – Spring 2019

Homework 1

Due before class on Wednesday 01/23

Warning for this and all future homeworks: the book has an overloaded numbering system with multiple types of problems. For example, Computer Exercise 2.3 is in page 111, Problem 2.3 is in page 100, Drill Problem 2.3 is in page 98, Computer example 2.3 is in page 94, and Example 2.3 is in page 24. I will specify the page (7th edition) for any assigned problems to avoid confusion, and I will also post scanned copies of the problems in Blackboard for those of you who have older editions of the book.

1. Prove the following:

- $\delta(t - a) * f(t) = f(t - a)$
- $A\delta(t - a) * B\delta(t - b) = AB\delta(t - a - b)$

2. The signal $x(t) = \sin(2\pi f_0 t)$ is the input to a system with impulse response $h(t) = e^{-\alpha t}u(t)$, $\alpha > 0$. Compute and sketch the Fourier transforms of the input $x(t)$ and output.
3. $x(t)$ is a real signal such that $x(-t) = x(t)$ (even). What is the relation between $X(f)$ and $X(-f)$? What is the imaginary part of $X(f)$?
4. The signal $x(t) = \cos(20\pi t)$ is sampled at 15 samples per second. Show that the signal $\cos(10\pi t)$ impersonates $x(t)$ as far as sample values are concerned. If $x(t)$ were sampled at 30 samples per second, could it be impersonated by any other function? Among all these, what makes $x(t)$ unique?
5. Prob. 2.66 pg. 109 (7th edition of the book. Otherwise, see scanned problems on blackboard). For parts b and c, it is enough to draw a plot and include a few sentences of discussion.
6. Problem 2.71, pg. 110 (7th edition of the book. Otherwise, see scanned problems on blackboard).
7. The spectrum of an audio message is known to be 0 for frequencies above 4 kHz. a) What is the minimum sampling rate you would need to allow recovery without distortion? b) If the message is restricted to the band between 3 kHz and 4 kHz, and this fact is known by both the transmitter and the receiver, can they use a lower sampling rate? If so, give an example, otherwise explain why not.
8. Sketch or plot the time domain signal whose spectrum is

$$X(f) = \sum_{k=-\infty}^{\infty} [\delta(f - 10 + 21k) + \delta(f + 10 + 21k)]$$

