

## Lecture S16 Muddiest Points

### General Comments

Today, we talked about the Fourier transforms of signals that are not stable, but are almost stable. These signals include constants, and sines and cosines. These signals are really important for understanding communication systems.

### Responses to Muddiest-Part-of-the-Lecture Cards

(9 cards)

1. *You never got to this in lecture ... you mentioned last semester your device for measuring complex impedance, yet no complex signals exist. can you explain? (1 student)* Sure. One way to do this is to apply a current,  $i(t)$ , to the impedance to be measured, and then measure the voltage signal,  $v(t)$ . Then the impedance is

$$Z(j\omega) = \frac{V(j\omega)}{I(j\omega)}$$

which makes sense if  $I(j\omega)$  is not zero for any  $\omega$ . Therefore, the measuring device must make sure that  $i(t)$  is an appropriate test current. Typically, this is done by using either a broadband, or white noise, process, or by using a swept sine signal.

2. *Could you explain the significance of duality, and how it can be applied to problems? (1)* We'll do this in recitation tomorrow.
3. *Can you show pictorially how the sine and cosine transforms are what they are? (With triangles or something.) (1)* Hmm, I'm not sure what you are asking. Please see me.
4. *Went too fast, but maybe I'm just tired. (1)* Maybe. Today didn't feel that fast to me.
5. *Could you do an equivalent bilateral cosine Laplace transform for what we did with Fourier in the last PRS? (1)* Sure. The LT is

$$\mathcal{L}[\cos(\omega_r t)\sigma(t)] = \frac{f}{f^2 + \omega_r^2}, \quad \text{Re}[f] > 0$$

Note that the region of convergence does not include  $\text{Re}[s] = 0$ , so the Fourier transform cannot be found simply by setting  $s = j\omega$ .

6. *Why is*

$$\mathcal{F}\{f(t)\}^* = \mathcal{G}(|\omega - \omega_r|)$$

*How do you know that there's a shift? (1)* We went over this in S15. The FT is

$$\mathcal{F}\{f(t)\}^* = \int f(t) e^{j(\omega_r - \omega)t} dt = \int f(t) e^{j(\omega_r - \omega)t} dt = \mathcal{G}(|\omega - \omega_r|)$$

7. *If  $u = \omega/a$ , shouldn't  $du = d\omega/a$ ? (1)* Yes. That's what I did — I replaced  $d\omega/a$  by  $du$ .
8. *How is it that you need Laplace transforms to find the Fourier transforms of  $\sigma(t)g(t)$ . (1)* If I understand your problem, you mean for the cases where  $g(t)$  is a constant, or a complex exponential, or a cosine or sine, as in our examples today. For these signals, the FT integral doesn't converge; however, there is a limiting sequence of signals, with convergent FTs. We can then find the limit of the FTs, and define this as the FT of the signal.
9. *No mud. (1)*