EE320 Signals and Systems I

Chapter 2 Study Guide

In order to do well on a test covering Chapter 2 material, you should be able to:

1. Describe in your own words (mathematically and graphically) how DT unit impulse can be used to construct an arbitrary signal $x[n]$ using the *sifting property*. I.e., describe how an arbitrary DT signal $x[n]$ can be composed of a superposition of scaled and shifted impulses.

2. Replicate the derivation of the *convolution sum*, explicitly pointing out where we invoke the properties of *linearity* and *time-invariance* and how these properties allow us to simplify the expression.

3. Given a simple, short duration $x[n]$ and simple, short duration $h[n]$, determine the output $y[n]$ by convolution. These simple expressions can be evaluation directly via the summation (i.e., a finite and small number of terms to evaluate like example 2.1).

4. Given an input signal $x[n]$ and impulse response $h[n]$, determine the output $y[n]$ by convolution. This may involve a combination of the following intermediate steps: (1) sketch $x[k]$ vs. k or $h[k]$ versus k, (2) sketch $h[-k]$ vs. k or $x[-k]$ vs. k, (3) sketch $h[n-k]$ vs. k or $x[n-k]$ vs. k, (4) determine different intervals of n for which the limits on the convolution sum will be different, (5) determine the summand for the convolution sum, (6) determine the limits of k for which the convolution sum must be evaluated for each of the intervals in n, (7) evaluation of the convolution sum which may involve use of the various summation formulae developed in class, (8) express $y[n]$ in closed form, (9) sketch $y[n]$ vs. n.

5. Describe in your own words how the CT stairstep approximation to a signal can be used to prove that an arbitrary CT signal can be composed of a superposition of scaled and shifted impulses.

6. Given an input signal $x(t)$ and impulse response $h(t)$, determine the output $y(t)$ by convolution. This may involve a combination of the following intermediate steps: (1) sketch $x(\tau)$ vs. τ or $h(\tau)$ vs. τ, (2) sketch $h(-\tau)$ vs. τ or $x(-\tau)$ vs. τ, (3) sketch $h(t-\tau)$ vs. τ or $x(t-\tau)$ vs. τ, (4) determine different intervals of t for which the limits on the convolution integral will be different, (5) determine the integrand for the convolution integral, (6) determine the limits of tau for which the convolution integral must be evaluated for each of the intervals in t, (7) evaluation of the convolution integral, (8) express $y(t)$ in closed form, (9) sketch $y(t)$ vs. t.

7. Describe in your own words the significance of the impulse response of a system, and the use of convolution.

8. Apply the *commutative*, *distributive*, and *associative* properties of convolution to help compute the convolution sum or integral.

9. Given the impulse response of a DT or CT LTI system, prove whether that system has the properties of (1) *Memory*, (2) *Causality*, and (3) *Stability*.

10. Given the impulse response of a DT or CT system, compute the step response.

11. Given a CT LCCDE, determine the *homogeneous solution*. Given a specific input to the LCCDE, determine the *particular solution*. Use conditions of initial rest to fully specify the total solution.

12. Given a CT LCCDE, determine the impulse response by first determining the step response.

13. Given a DT LCCDE, use the property of recursion to determine the output for a given input (which may be an impulse or step function), including expression of y[n] in closed form.

14. Given a CT or DT LCCDE, draw a *block diagram* representation of that system (using integrators instead of differentiators for CT). Given a block diagram representation of a CT or DT system, specify the LCCDE.

15. Recognize and use the *identity property* of the unit impulse under convolution to quickly evaluate and sketch the output of convolution.