

## Test #2 Overview

### Related Textbook Material

Ch. 1, Sect. 1-4, 6-8 and Ch. 2, Sect. 1-8 in *Linear Signals & Systems, 2<sup>nd</sup> Ed.* by Lathi  
Ch. 13, Sect. 6 in *Electric Circuits, 8<sup>th</sup> Edition* by Nilsson

### Related Assignments

Homework Assignments #3 - 4

### Related Powerpoint Presentations

Lectures #7 - 11

### Test Format

No books, no notes

All calculators allowed

Multiple-choice, True/False problems (especially for signal & system properties)

Calculation-oriented problems

Graphing problems (convolution, signal operations)

### Signals & Systems

Energy and power signals:

- Determine whether a signal is an energy signal, a power signal, or neither.
- Calculate energy, power, and RMS values

Signal operations:

- Time-shifting, time-scaling (compression & expansion), time-reversal
- Sketching or identifying shifted, scaled, and/or reversed signals
- Expressing a waveform in terms of other waveforms

Classification of signals: (Be able to identify given a function or graph)

- Continuous-time and discrete-time signals
- Analog and digital signals
- Periodic and aperiodic signals
- Energy and power signals
- Deterministic and probabilistic signals

Useful signal models:

- $\delta(t)$ ,  $u(t)$ ,  $e^{st}$
- Sifting property – evaluate functions or integrals

Classification of systems: (Be able to identify given a function, circuit, or graph)

- Linear and non-linear systems: Determine if a given function is linear using two key tests:
  1. Linearity:  $kf(x) = f(kx)$
  2. Additivity:  $f(x_1 + x_2) = f(x_1) + f(x_2)$
- Time-invariant (or constant parameter) and time-varying systems
- Static (instantaneous or memoryless) or dynamic (with memory) systems
- Causal and noncausal systems
- Continuous-time and discrete-time systems
- Analog and digital systems
- Invertible and noninvertible systems

- Stable and unstable systems

## Representation and Analysis of Systems

1. Differential equations
  - Find the D.E. (review from EGR 260)
  - Find the unit step response, USR, or the impulse response,  $h(t)$  from a D.E. (review)
  - Given the USR, find the impulse response =  $h(t) = d/dt[USR(t)]$
  - Find  $H(s)$  from the D.E.
2. Transfer functions
  - Find the transfer function using Laplace transforms (review - covered on Test #1)
  - Use the transfer function to find  $h(t)$ , USR, or  $y(t)$  for any  $x(t)$  (review – covered on Test #1)
3. **Convolution** (major topic – perhaps 40% - 50% of test)

- Definition :  $f(t) * g(t) = \int_{-\infty}^{\infty} f(\tau)g(t - \tau)d\tau$

- Graphical approach only
- Include accurate sketches to illustrate the solution.
  - Clearly list range of  $t$  where each intersection occurs
  - Clearly list the corresponding limits of integration
- Convolution integral properties - for example,  $g(t)*f(t) = f(t)*g(t)$ 
  - So you can delay and shift either signal. Delay and shift the simplest signal!
- Length of the convolution of two signals = sum of the lengths of the individual signals