EECS2602.4 Continuous Signals and Systems   LASSONDE | YORK U

No. 1
Signals and Systems:
Introduction

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Course Outline (EECS2602)

- Introduction:
  - Signals and Systems in Continuous time (CT)
  - Properties and Operations
- Linear Systems Analysis
  - **Time domain analysis**
  - **Fourier analysis (Frequency analysis)**
  - **Laplace analysis**
- Engineering Applications:
  - RCL electrical circuits (electronics)
  - Filter design (signal processing)
  - Modulation (communication)
  - Linear Feedback (control)
- Advanced Engineering Mathematics
  - Complex numbers and functions
  - Ordinarary differential equations

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Tentative Schedule (EECS2602)

- Unit 1 – Introduction
  - Signals and Systems in Continuous time (CT)
  - Properties and Operations
  - **Quiz 1**

  - Lab one

- Unit 2 – Time Domain Linear Systems Analysis
  - Ordinarary differential equations
  - Impulse response of a linaer
  - Convolutional integral
  - **Quiz 2**

  - Lab two

- Unit 3 – Fourier Analysis of Linear Systems
  - Fourier series and Fourier transform
  - Frequency response of linear systems
  - **Quiz 3**

  - Lab three

- Unit 4 – Laplace analysis of Linear Systems
  - Laplace transform
  - Transfer function of linear systems
  - **Quiz 4**

  - Lab four

- Unit 5 – Engineering Applications
  - Filter design (signal processing)
  - Linear Feedback (control systems)
  - **Final Exam**

  - Lab five

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Course Evaluation (EECS2602)

- Assignments and in-class quizzes (40% in total)
  - 4-5 assignments (optional, 0%)
  - 3-4 in-class quizzes (1 hr each, 40% in total)

- 4-5 Labs (20% in total): M (10:00-13:00) @WSC
  - Lab1: matlab introduction
  - Lab2: audio signals
  - Lab3: music synthesis
  - Lab4: amplitude modulation
  - Lab5: sound synthesis (?)

- Final exam (40% in total)

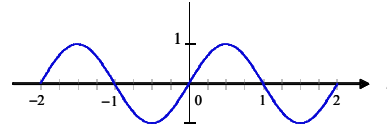15-01-04   4

Signals

- What are signals?

Signals

Prepared by Prof. Hui Jiang

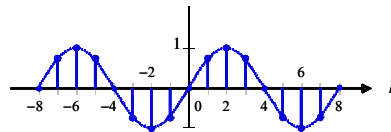# Signal Types (I)

- Analogue Signals

  – Continuous Time (CT) Signals

- Discrete Signals

  – Discrete Time (DT) Signals

Signal Types (II)

- Periodic vs. Aperiodic Signals

  – Fundamental frequency

  – Harmonics
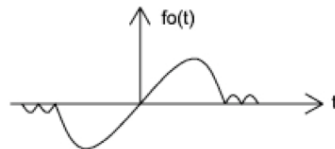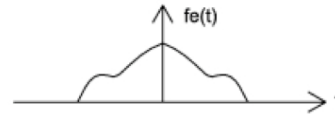
  – Examples: sinusoidal signal, complex exponential

  – Superposition

Signal Types (III)

• Even vs. Odd signals

• Any signal can be decomposed to an odd and an even signal

• Superposition

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Energy and Power

• Definition
  – Energy/Power signals

• Energy signals

• Power signals

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Real vs. Complex Signals

- Real signals

- Complex signals

- Complex numbers (reviews)

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Elementary Signals (I)

- Unit step signal

- Rectangular pulse signal

- Signum signal

- Ramp signal

- **Unit impulse signal**

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Elementary Signals (I)

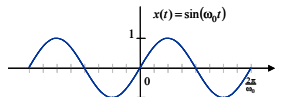$x(t) = u(t)$

$x(t) = \text{rect}\left(\frac{t}{\tau}\right)$

$x(t) = \text{sgn}(t)$

Area = 1

$1/\varepsilon$

-0.5ε 0.5ε

$\delta(t)$
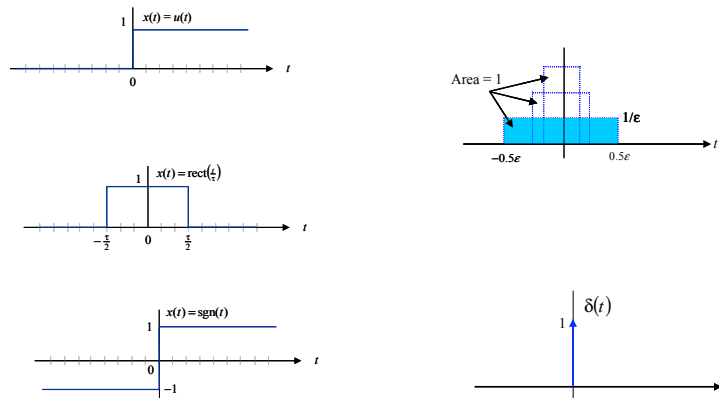
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Elementary Signals (II)

- **Sinusoid signals (CT)**

- Sinc signals (CT)

- **Exponential signals (CT)**
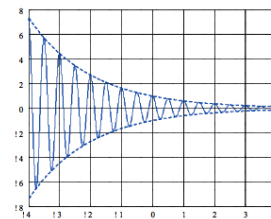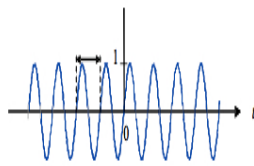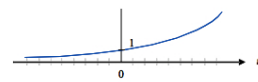
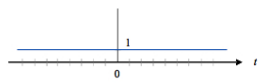 – Real-valued

  – Complex-valued

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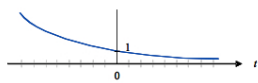# Elementary Signals (II)
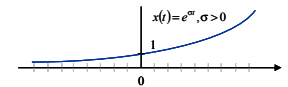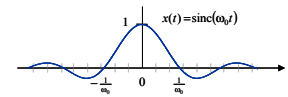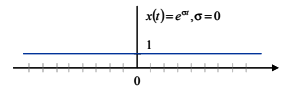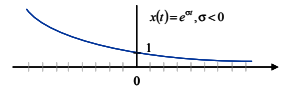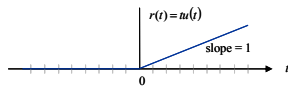
Elementary Signals (II)

Signal Operations

- Scaling

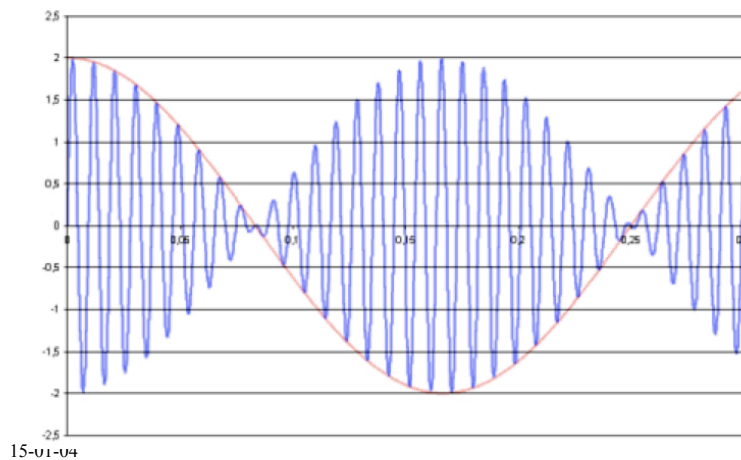- Time shift

- Time scaling

- Time reversal

- Combined operation:

- Linear Combination of signals

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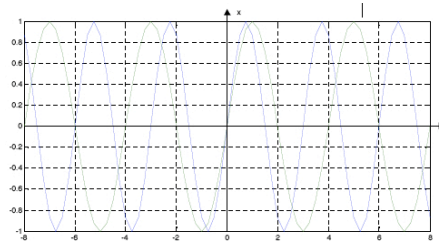
Beat Frequency

- Superposition of two sinusoidal signals

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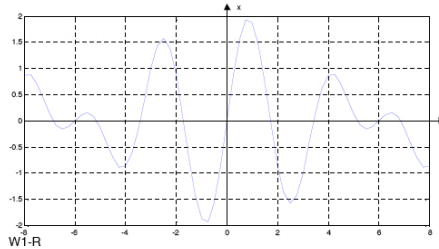
Beat Frequency

- CT signals are:

$$x_1(t) = \sin\left(\frac{2\pi}{3}t\right)$$

$$x_2(t) = \sin(0.5\pi t)$$

- Signal superpostion
- What is the period of this signal?
- Use trig identities to show

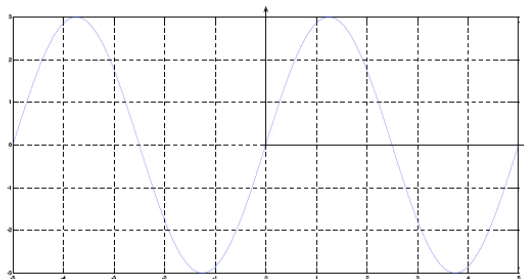$$x_1(t) + x_2(t) = 2\cos\left(\frac{\pi}{12}t\right)\sin\left(\frac{7\pi}{12}t\right)$$

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Signal Review (I)

Determine the values of T which make the following signal (a) an even signal and (b) and odd signal
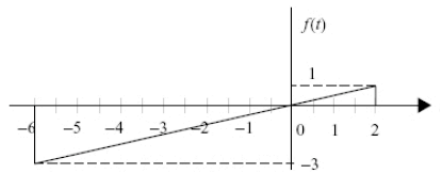
$$x(t) = 3\sin\left(\frac{2\pi(t-T)}{5}\right)$$

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Signal Review (II)

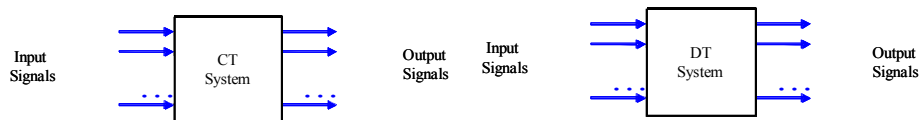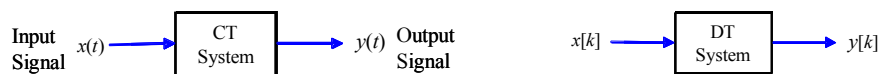Express the following signal as a combination
of a unit step and ramp functions

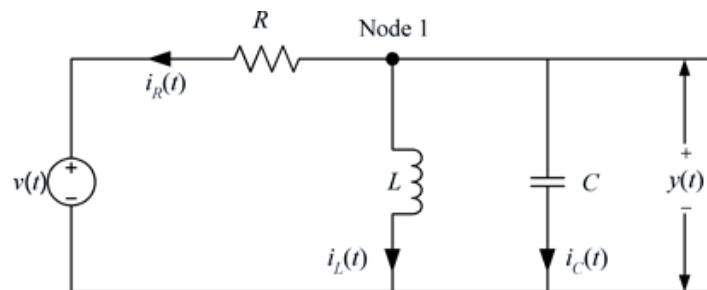15-01-04   21

Systems

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CT System Example (I): RCL circuits

R Node 1

$i_R(t)$

$v(t)$

L

$i_L(t)$

C

$i_C(t)$

$y(t)$

CT System Example (II): Amplitude Modulator (AM)

$m(t)$
Modulating Signal → Attenuator → $km(t)$ → (+) → $(1 + km(t))$ → Modulator → $s(t)$ **Modulated Signal**

Offset for Modulation

$A\cos(2\pi f_c t)$
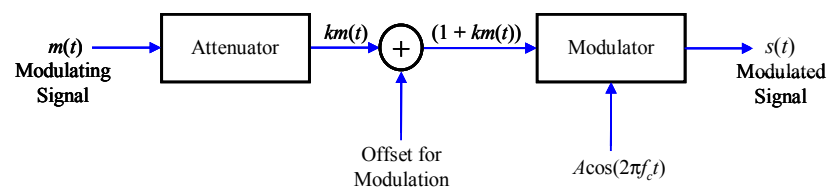
System Types

- Linear vs. non-linear systems
- Time-varying vs. time-invariant systems
- Memory vs. memoryless memory
- Causal vs. non-causal systems
- Invertible vs. non-invertible systems
- Stable vs. unstable systems

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System Interconnection

- Cascaded configuration

- Parallel configuration

- Feedback configuration

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