

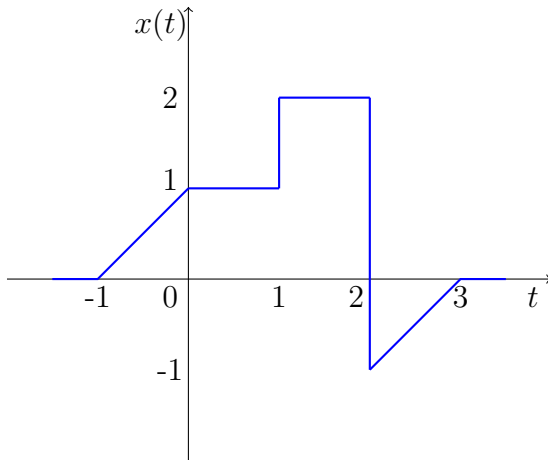
EE1101 Signals and Systems JAN—MAY 2018
Tutorial 1

1. Given a continuous-time signal specified by

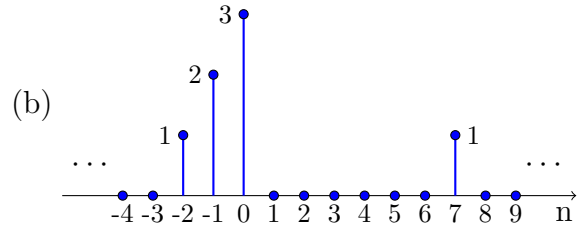
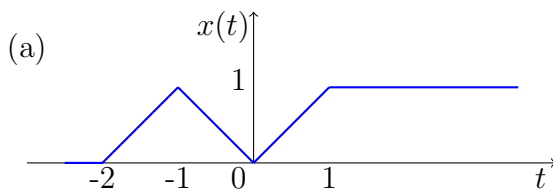
$$x(t) = \begin{cases} 1 - |t|, & -1 \leq t \leq 1 \\ 0, & \text{otherwise} \end{cases}$$

Plot the discrete-time sequence that results from uniform sampling of $x(t)$ for the following sampling intervals: (a) 0.25 s, (b) 0.5 s, and (c) 1 s.

2. For the continuous time signal $x(t)$ shown below, sketch and label carefully each of the following signals: (a) $x(t - 1)$, (b) $x(2 - t)$, (c) $x(2t + 1)$, (d) $x(4 - \frac{t}{2})$, (e) $[x(t) + x(-t)]u(t)$ and (f) $x(t)[\delta(t + \frac{3}{2}) - \delta(t - \frac{3}{2})]$.

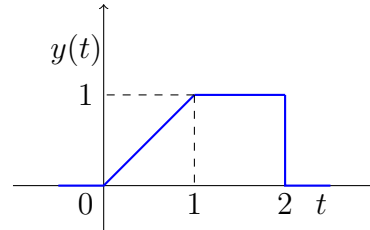


3. Determine and sketch the even and odd parts of the signals depicted in figures below. Label your sketches carefully.



4. Consider the signal $y(t) = (1/5)x(-2t - 3)$ shown below.

- (a) Determine and carefully sketch the original signal $x(t)$.
(b) Determine and carefully sketch $y_o(t)$, the odd portion of $y(t)$.



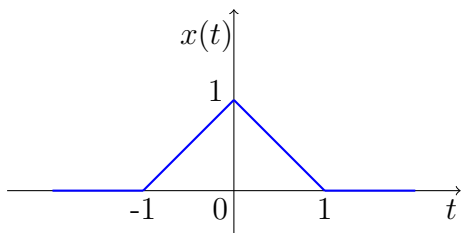
5. A sinusoid $e^{\sigma t} \cos \omega t$ can be expressed as a sum of exponentials e^{st} and e^{-st} with complex frequencies $s = \sigma + j\omega$ and $s = \sigma - j\omega$. Locate in the complex plane the frequencies of the following sinusoids:

- (a) $\cos 3t$, (b) $e^{-3t} \cos 3t$, (c) $e^{2t} \cos 3t$, (d) e^{-2t} , (e) e^{2t} , and (f) 5.

6. (a) Show that the power of the signal $x(t) = \sum_{k=m}^n D_k e^{j\omega_k t}$ is $P_x = \sum_{k=m}^n |D_k|^2$ assuming all frequencies to be distinct i.e. $\omega_i \neq \omega_j$ for $i \neq j$.

- (b) Determine the power and the RMS value of the signals (a) $x(t) = 10 \cos 5t \cos 10t$ and (b) $x(t) = 10 \cos(100t + \frac{\pi}{3}) + 5 \sin(100t + \frac{\pi}{6})$

7. Consider the signal $x(t)$ shown in figure.



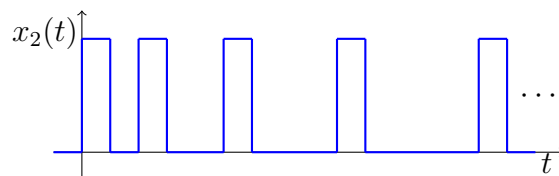
- (a) Determine and carefully sketch $y(t) = 3x(-\frac{1}{2}(t+1))$.
 - (b) Determine the energy and power of $y(t)$.
 - (c) Determine and carefully sketch the even portion of $y(t)$, $y_e(t)$.
 - (d) Let $a = 2$ and $b = 3$, sketch $y(at+b)$, $y(at) + b$, $ay(t+b)$ and $ay(t) + b$.
8. Let the energy of signal $x(t)$ be denoted by E_x . Show that
- (a) The signals $-x(t)$, $x(-t)$ and $x(t-T)$ have the same energy.
 - (b) The energy of $x(at)$ and $x(at-b)$ is $\frac{E_x}{|a|}$.
9. The unit pulse function $\Pi : \mathbb{R} \rightarrow \mathbb{R}$ is defined as

$$\Pi(t) = \begin{cases} 1, & -\frac{1}{2} \leq t \leq \frac{1}{2} \\ 0, & \text{otherwise} \end{cases}$$

Sketch the following signals and evaluate the energy of each one of them

- (a) $\Pi(2t)$.
 - (b) $6\Pi(0.5t)$.
 - (c) $\Pi(t-4)$.
 - (d) $\Pi(\frac{t+1}{2}) + \Pi(t-1)$.
10. (a) A binary signal $x_1(t) = 0$ for $t < 0$. For positive time, $x_1(t)$ toggles between one and zero in every one second. Determine the energy and power of $x_1(t)$.

- (b) A binary signal $x_2(t) = 0$ for $t < 0$. For positive time, $x_2(t)$ toggles between one and zero as follows: one for 1 second, zero for 1 second, one for 1 second, zero for 2 seconds, one for 1 second, zero for 3 seconds, and so forth. That is, the “on” time is always one second, but the “off” time successively increases by one second between each toggle. A portion of $x_2(t)$ is shown below. Determine the energy and power of $x_2(t)$.



11. Determine which of the following signals are periodic. If a signal is periodic, what is the fundamental period and average power?
- (a) $\cos(\pi t)$.
 - (b) $A \sin(10\pi t)$.
 - (c) $\sin(\sqrt{3}\pi t)$.
 - (d) e^{jt} .
 - (e) $A \sin(4\pi t + \pi)$.
 - (f) $\sum_{n=-\infty}^{\infty} \Pi(t-2n)$.
12. Carefully sketch the following signals. Mark all the critical points.
- (a) $h(t) = e^{-tu(t)}$, $-1 \leq t \leq 1$
 - (b) $p[n] = (\frac{1}{2})^n u[n-3]$
 - (c) $g(t) = \frac{d}{dt}(u(t-2)r(t))$
 - (d) $f(t) = \text{sgn}(e^{-2t} \sin 2\pi t)$,
 $\text{sgn}(t) = u(t) - u(-t)$

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