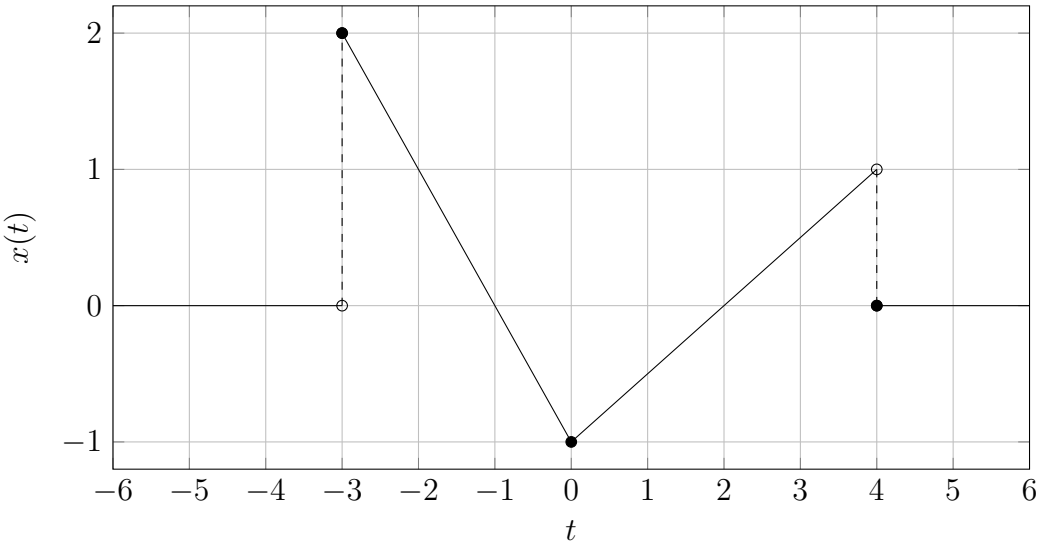
Signals & Systems Homework #1
154 points total

ECE 315 – Fall 2022

Due Monday, October 10, 2022

1. Consider the signal $x(t)$ shown below, where $x(t) = 0$ for all values of t not shown. All plots must be done by hand. (No credit for using an electronic device to do the plotting for you.)



   (a) Plot $-3x(t)$. (5 pts.)
   (b) Plot $x(t+2)$. (5 pts.)
   (c) Plot $x(t/2)$. (5 pts.)
   (d) Write $x(t)$ as a function. (8 pts.)
   (e) Determine the generalized derivative of $x(t)$ and plot it. (8 pts.)

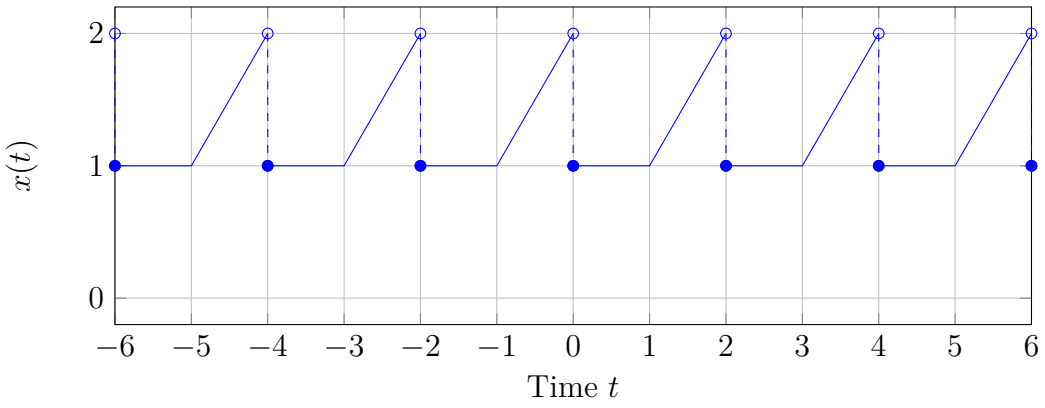


Figure 1: A periodic signal $x(t)$ with $T_0 = 2$ and amplitudes $H = 2$, $h = 1$

2. (a) Write a MATLAB or python script that recreates the plot of the periodic signal $x(t)$ shown in Figure 1 with fundamental period $T_0 = 2$, maximum amplitude $H = 2$, and minimum amplitude $h = 1$ between $t = -6$ and $t = 6$. Make the fundamental period T_0 and the amplitudes H and h variables in your script. Include your code and an image showing the graphical output in your homework solutions. (12 pts.)

   (Hint: The 2D plotting functions in MATLAB and in the python library matplotlib draw line segments connecting successive points. So, you really just need to plot the important points in the correct order.)

   (b) Plot

$$y(t) = -2x\left(\frac{t+1}{3}\right)$$

   between $t = -12$ and $t = 12$ by hand or using a modified version of your script. (10 pts.)

   (c) Create a block diagram showing the simple transformations involved in Part (b) in a proper order. (5 pts.)

   (d) Draw the block diagram that results when you interchange time shifting and time scaling in Part (c) and plot the signal $\tilde{y}(t)$ that results from this altered transformation between $t = -12$ and $t = 12$ by hand or using a modified version of your script. (10 pts.)

3. (a) Calculate $\int_{-\infty}^{\infty} \delta(t-5)\sin\left(\frac{3\pi}{10}t\right)\,dt$. (3 pts.)

   (b) Calculate $\int_{-10}^{10} \delta\left(-\frac{t+4}{5}\right)e^{-\frac{t}{2}}\,dt$. (6 pts.)

   (c) Calculate $\int_{-3}^{3} \delta(t-6)\left(\frac{t^2+1}{t+12}\right)\,dt$. (3 pts.)

4. Determine whether the following signals are periodic and, if so, determine the fundamental period, fundamental frequency, and fundamental angular frequency. Feel free to use software to determine the LCM, if needed.

   (a) $x(t) = \sqrt{2}\sin\left(\frac{24}{5}t - \frac{\pi}{12}\right) + 7\sin\left(\frac{8\pi}{5}t - \frac{\pi}{9}\right)$ (6 pts.)

   (b) $x(t) = \frac{5}{8}\cos\left(\frac{7}{15}t + \frac{3\pi}{7}\right) - \sqrt{3}\cos\left(\frac{16}{35}t - \frac{17}{5}\right)$ (6 pts.)

   (c) $x(t) = x_1(t) + x_2(t)$, where $x_1(t) = 2\sin\left(\frac{13}{40}t - \frac{3\pi}{11}\right)$ and $x_2(t)$ is the function in Figure 1. (6 pts.)

   (d) $x(t) = x_1(t) + x_2(t)$, where $x_1(t)$ is the function in Figure 1 and $x_2(t)$ is the function in Figure 2. (6 pts.)

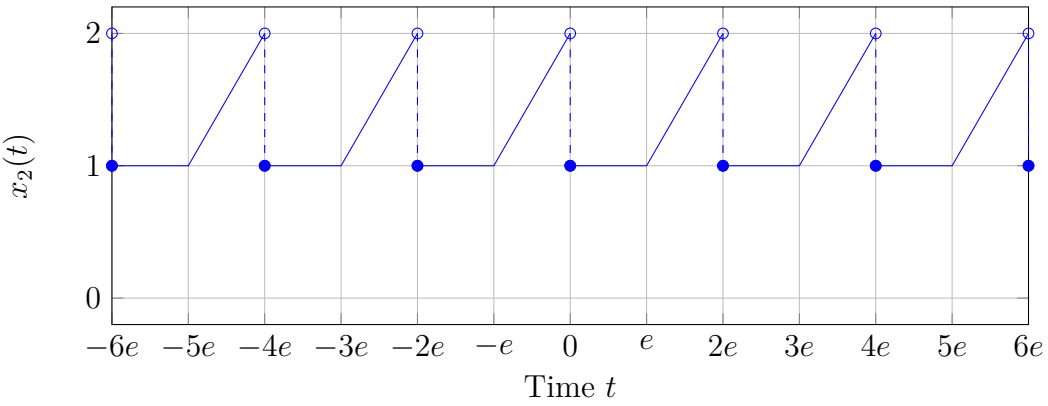


Figure 2: Another periodic signal $x_2(t)$

5. Find the even and odd parts of

   (a) the signal $x(t)$ from Problem 1 (8 pts.)

   (b) the signal $x(t) = e^{j\omega t}$ (6 pts.)

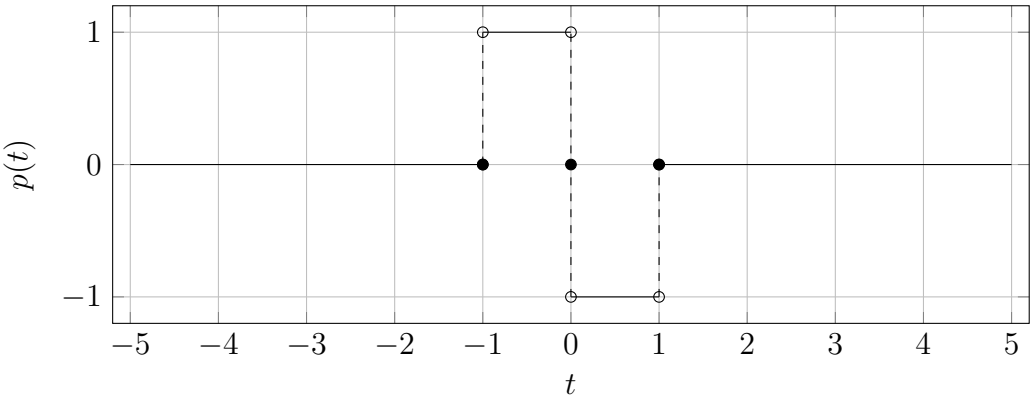
   (c) the signal $x(t) = 2(t^2+3t+2)\cos(\frac{5\pi}{2}t)$. (6 pts.)

6. Use the symmetry properties of the integrands to evaluate the following integrals in the simplest ways.

   (a) $\int_{-\pi}^{\pi} \left(\cos\left(\frac{3}{5}t\right) - \sin\left(\frac{2}{7}t\right)\right)\, dt$ (6 pts.)

   (b) $\int_{-\sqrt{2}}^{\sqrt{2}} t^2 \tan(\frac{\pi}{4}t)\, dt$ (4 pts.)

7. (a) Find the energy of $x(t) = 2te^{-\frac{t}{2}}\, p\left(\frac{t+1}{3}\right)$, where $p(t)$ is the pulse shown below. (8 pts.)



   (b) Find the average power of $x(t) = 5e^{-j\frac{2}{5}t}$. (6 pts.)

   (c) Is $x(t) = 3e^{-j\left(\frac{3\pi}{2}t - \frac{\pi}{2}\right)}u(t)$ an energy or a power signal? Why? (6 pts.)