EES 351: In-Class Exercise # 11

Instructions

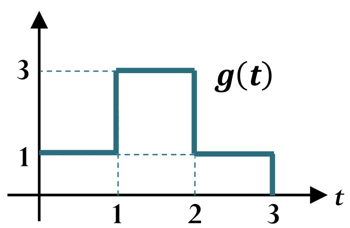
1. Work alone or in a group of no more than three students. **The group cannot be the same as any of your former groups after the midterm.**
2. **[ENRE] Explanation is not required for this exercise.**
3. Only one submission is needed for each group.
4. You have two choices for submission:
   (a) Online submission via Google Classroom
   - PDF only.
   - Only for those who can directly work on the posted files using devices with pen input.
   - Paper size should be the same as the posted file.
   - No scanned work, photos, or screen capture.
   - Your file name should start with the 10-digit student ID of one member. (You may add the IDs of other members, exercise #, or other information as well.)

   (b) Hardcopy submission
5. **Do not panic.**

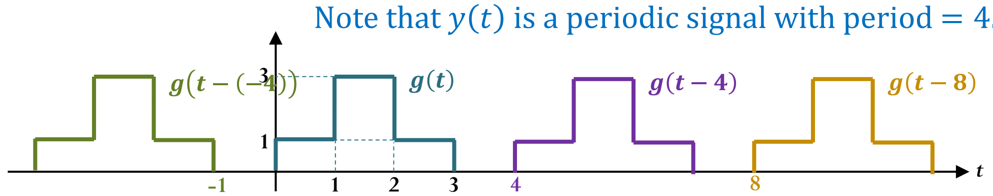
Date: 9 / 10 / 2020			
Name	ID (last 3 digits)		

1. Consider two signals $g(t)$ and $y(t)=\sum_{k=-\infty}^{\infty} g(t-4k)$.

The signal $g(t)$ is plotted below. Note that $g(t)=0$ outside of the interval $[0,3]$.



Note that $y(t)$ is a periodic signal with period $= 4$.



For each signal, calculate its (a) time average, (b) (total) energy, (c) (average) power and then indicate (by putting a Y (for a yes) or an N (for a no)) in part (d) whether it is an energy signal and in part (e) whether it is a power signal.

	$g(t)$	$y(t)$
(a) Time Average	$\langle g(t)\rangle = \lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T} g(t)\,dt$ For $T>3$, $\int_{-T}^{T} g(t)\,dt = \int_0^3 g(t)\,dt = 1+3+1=5$. Therefore, $\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T} g(t)\,dt = \lim_{T\to\infty}\frac{1}{2T}\times 5 = 0$.	For periodic signal, $\langle y(t)\rangle = \frac{1}{T_0}\int_{T_0} y(t)\,dt$ $= \lim_{T\to\infty}\frac{1}{4}(1+3+1) = \frac{5}{4}$.
(b) (Total) Energy	$E_g = \int_{-\infty}^{\infty} \|g(t)\|^2\,dt$ $= 1^2+3^2+1^2 = 11$.	By definition, $E_y = \int_{-\infty}^{\infty}\|y(t)\|^2\,dt$. Now, note that, in this integration, each period of $y(t)$ gives 11 units of energy. So, its total energy is $\cdots + 11 + 11 + 11 + \cdots = \infty$. Alternatively, in the later part, we will show that $y(t)$ is a power signal. Any power signal has infinite energy.
(c) (Average) Power	$P_g = \langle \|g(t)\|^2\rangle = \lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T}\|g(t)\|^2\,dt$. For $T>3$, $\int_{-T}^{T}\|g(t)\|^2\,dt = \int_0^3 g^2(t)\,dt = 1^2+3^2+1^2 = 11$. Therefore, $\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T}\|g(t)\|^2\,dt = \lim_{T\to\infty}\frac{1}{2T}\times 11 = 0$. Alternatively, in the later part, we will show that g(t) is an energy signal. Any energy signal has zero average power.	For periodic signal, $P_y = \frac{1}{T_0}\int_{T_0}\|y(t)\|^2\,dt$ $= \frac{1}{4}(1^2+3^2+1^2) = \frac{11}{4}$.
(d) Energy Signal?	Y $E_g = 11$ is "> 0" and "$< \infty$". Therefore, $g(t)$ is an energy signal.	N $y(t)$ can not be an energy signal because $E_y = \infty$. Alternatively, in the later part, we will show that $y(t)$ is a power signal. Any power signal cannot be an energy signal.
(e) Power Signal?	N Because we have shown that $g(t)$ is an energy signal, it can not be a power signal.	Y $P_y = \frac{11}{4}$ is "> 0" and "$< \infty$". Therefore, $y(t)$ is a power signal.