ENGR 4333/5333: Digital Signal Processing

HW 4: Ch4

1) State with reason(s) whether the following signals are periodic:

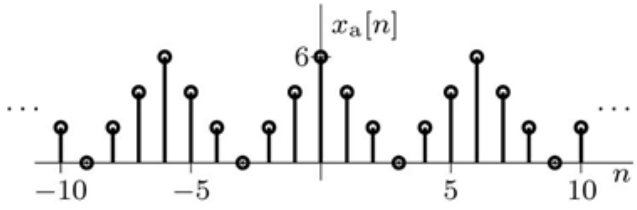
(a) $\cos(0.6\pi n + 0.3) + 3\sin(0.5\pi n + 0.4)$

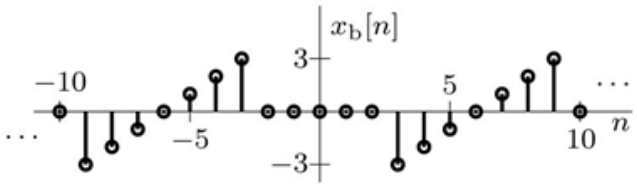
(b) $\cos(1.6\pi n + 0.3) + 3\sin(1.5\pi n + 0.4) + 8\cos(1.8\pi n - \pi/3)$

(c) $\cos(0.7\pi n + 0.3) + 3\sin(0.5n + 0.4)$

2) If $x[n] = n\,(u[n-1] - u[n-5])$, sketch signals $x[n]$, $-x[n]$, $x[-n]$, $x[n+1]$, and $3x[n]$, and find their energies.

3) Find the powers of the signals depicted in Figures below.





4) (a) Derive an approximation of $d^3y(t)/dt^3$ in terms of finite differences. Use the equation given in the lecture to verify but not obtain your result.

(b) Find a difference equation, including initial conditions, that approximates the behavior of the second-order difference equation $d^2y(t)/dt^2 + 3\,dy(t)/dt + 2y(t) = x(t)$, where $y(0) = 0$ and $dy(0)/dt = 3$. Take the sampling interval as $T = 0.05$.

5) A variable, such as a stock market average, may fluctuate (up and down) daily, masking its long-term trend. We can discern such long-term trends by smoothing or averaging the past N values of the variable. For the stock market average, we may consider a 5-day moving average $y[n]$ to be the mean of the past five days' market closing values $x[n]$, $x[n-1]$, . . . , $x[n-4]$.

(a) Write the nonrecursive representation of this system.

(b) Determine a block realization of this system.

(c) Find the recursive representation of the 5-day moving-average system.

(d) Determine a block realization of this recursive system.

6) State with reason(s) whether the following systems are (1) time invariant or time variant, (2) linear or nonlinear, (3) causal or noncausal, (4) stable or unstable, (5) static or dynamic, and (6) invertible or noninvertible.

(a) $y[n] = x[n-1]$ (ideal unit delay)

(b) $y[n] = x[n+1]$ (ideal unit advance)

(c) $y[n] = n^2x[n-1]$

(d) $y[n] = nx[n-1]$

(e) $y[n] = nx^2[n]$

7) Suppose that a signal $x[n]$ is sampled at a rate $F_s = 1$ kHz.

(a) Determine an expansion factor L and compression factor M that result in a signal that reduces the sampling rate by 60% to $0.4F$s. Choose L and M to be coprime.

(b) Show that ordering the expander before the compressor requires each component to operate at faster sampling rates than if the compressor is ordered before the expander.