دانشگاه صنعتی امیرکبیر
(پلی تکنیک تهران)

Signals and Systems

Assignment 5

Fall 2019 - Group 1

Contact: MohammadKhalaji76@gmail.com
Telegram Channel: @SignalsAndSystems98Fall

Question 1

Let $x(t)$ be a signal with Nyquist rate ω_0. Determine the Nyquist rate for the following signals:

(a) $x(t) + x(t-1)$

(b) $\frac{dx(t)}{dt}$

(c) $x^2(t)$

(d) $x(t)cos(\omega_p t)$

Question 2

Determine the Nyquist rate for the following signals (if sampling without information loss is possible).

(a) $x(t) = e^{-5t}u(t)$

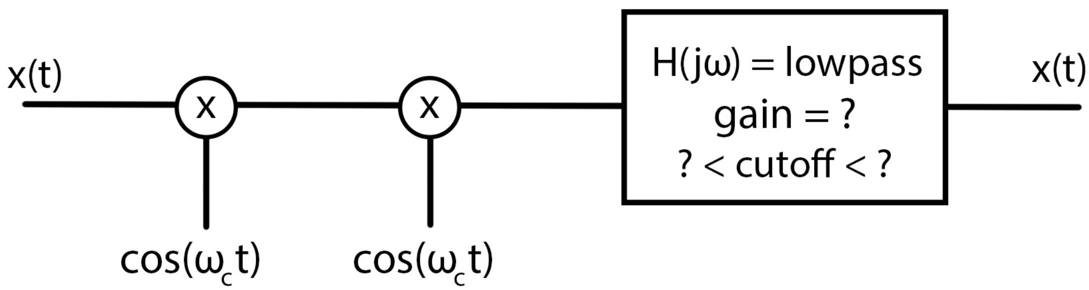
(b) $x(t) = 1 + cos(100\pi t) + cos(300\pi t)sin(50\pi t)$

(c) $x(t) = \frac{sin(400\pi t)}{\pi t}$ (Try sampling this signal with an invalid sampling frequency, sketch $X_p(j\omega)$, also sketch $X_p(j\omega)$ for a valid sampling frequency)

(d) $x(t) = u(t) - u(t-4)$

Question 3

Consider a band-limited signal $x(t)$, where $X(j\omega)$ is non-zero for only $-200\pi < \omega < 200\pi$ and looks like a symmetric triangle where $X(j0) = A$. Answer following questions in a way that makes this system act like a modulation-demodulation system (= final output is also $x(t)$).



(a) What is the valid range for ω_c? Choose an arbitrary value from that range and proceed to the next parts.

(b) What is the valid range for $H(j\omega)$'s cutoff?

(c) Determine the valid value for $H(j\omega)$'s gain.

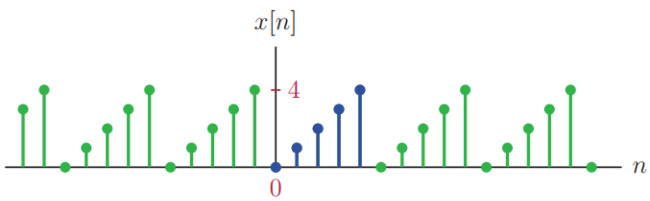
Question 4

Determine the Fourier Series coefficients for following signals:

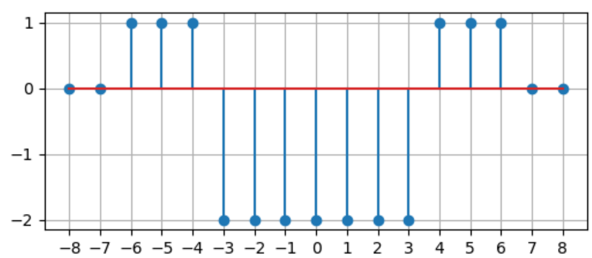
(a) $x[n] = 1 + cos(\frac{n\pi}{2}) + sin(n\pi)$

(b) $x[n] = \begin{cases} 1 & -N_1 < n < N_1 \\ 0 & otherwise \end{cases}$ (Periodic with $N > N_1$)

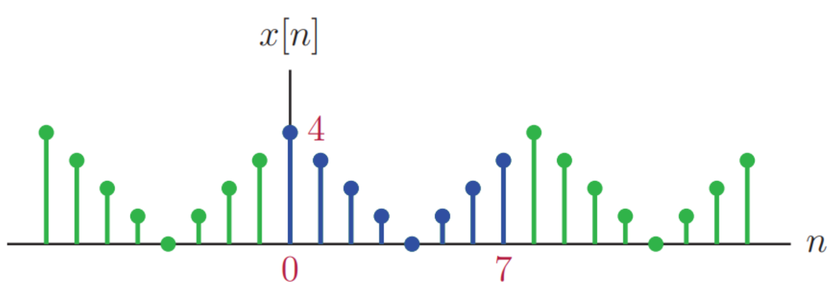
(c) .



(d) (Use the result from part b) ($N = 10$)



(e) .



Question 5

If we consider a_k as Fourier Series coefficients of $x[n]$, determine Fourier Series coefficients of following signals:

(a) $x^*[3-n]$

(b) $(-1)^n x[n]$ (Explain the circumstances in which $(-1)^n x[n]$ is periodic)

Question 6

Let $x[n]$ be a real and odd periodic signal with period $N = 9$ and Fourier Series coefficients a_k. Given that

$$a_{19} = j, a_{20} = 3j, a_{21} = 6j$$

determine the values of $a_0, a_{-1}, a_{-2}, a_{-3}$.