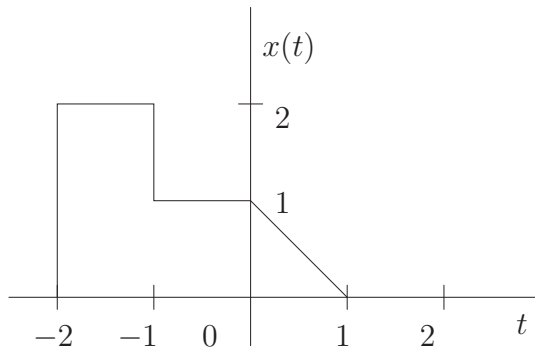
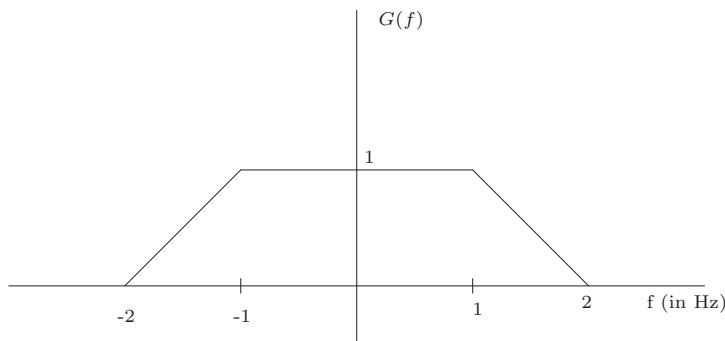


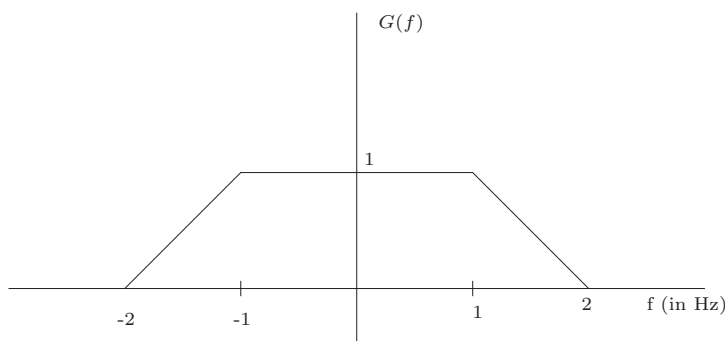
10. Choose the correct answer. The input to an LTI system is $\sin 20t + \cos 10t$. The output **cannot** be
- $\sin 20t$.
 - $\cos 20t + \sin 10t$.
 - $\sin 30t + \cos 10t$.
 - $\cos 20t$.
11. For the signal $x(t)$ shown below sketch and label $x(4 - 2t)$.



12. The Fourier Transform $G(f)$ of a continuous time signal $g(t)$ is shown below. Find $g(0)$.



13. The Fourier Transform $G(f)$ of a continuous time signal $g(t)$ is shown below. Find $\int_{-\infty}^{\infty} g(t)e^{-j2\pi t} dt$.



14. A signal $x(t)$ of bandwidth W has a Fourier transform $X(f)$ as shown in Figure 1. Sketch the Fourier transform of the sampled version of $x(t)$ given by $y(t) = \sum_{n=-\infty}^{\infty} x(nT)\delta(t - nT)$ and the discrete-time Fourier transform, $Z(e^{j\omega})$, of $z[n] = x(nT)$. Assume that $1/T > 2W$.
15. A signal $x(t) = 100 \cos(20000\pi t)$ is ideally sampled with a sampling period of $50 \mu\text{sec}$. Sketch possible sequences of the sampled output.
16. The transfer function of a certain LTI system is given by

$$H(z) = \frac{1 - 2z^{-1}}{1 - 2z}.$$

Find and plot the magnitude frequency response $|H(e^{j\omega})|$ versus ω for $-\pi < \omega < \pi$.

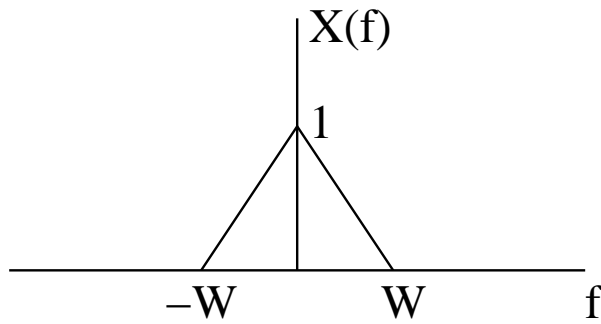
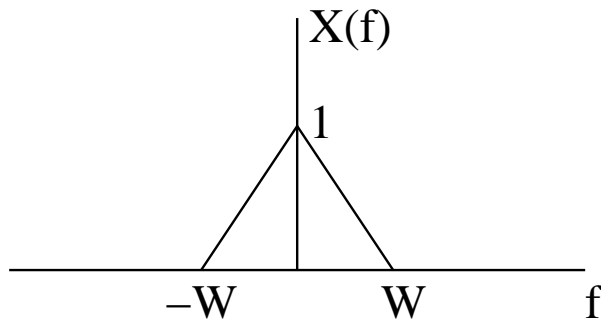


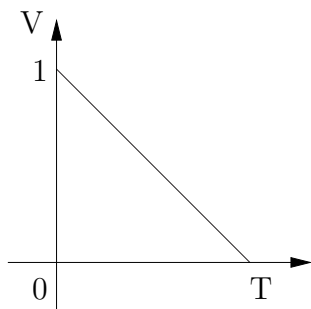
Figure 1:

Communications

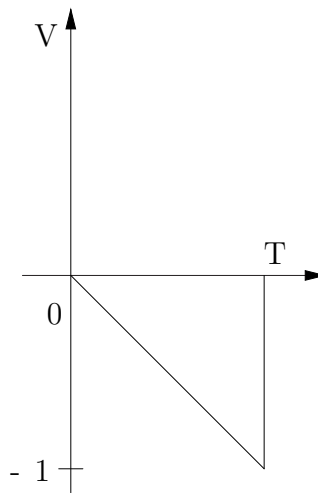
1. Given that X is an uniformly distributed random variable between -1 and $+1$, plot the probability distribution function of $Y = |X - 1|$.
2. Let $Y = X + N$, where X is $+1$ with probability $1/3$ or -1 with probability $2/3$, and N is a Gaussian random variable with zero mean and variance σ^2 independent of X i.e., the probability density function of N is $f_N(n) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{n^2}{2\sigma^2}\right]$. What is the probability density function of Y ?
3. A signal $x(t)$ of bandwidth W has a Fourier transform as shown below. Sketch the Fourier transforms of $y(t)$ and $z(t)$, where $y(t) = x(t) \cos 2\pi f_c t$ and $z(t) = y(t) \cos 2\pi f_c t$. Assume that $f_c > W$.



4. A signal $f(t) = \cos(100\pi t) + 3 \cos^2(80\pi t)$ is sent through an ideal low pass filter with cutoff at 60 Hz and sampled at 70 Hz to produce $g(kT)$. What frequency components are present in $g(kT)$ between 0 and 60 Hz?
5. A digital bit stream at a rate of 10 Mbps consists of a stream of bytes, each byte representing a 8-bit PCM word. What is the maximum bandwidth of the analog signal which this PCM can represent without distortion?
6. A binary communication system over an AWGN channel uses the following waveforms (shown in Figure) to indicate symbols 0 and 1 which occur with equal probability. Sketch the impulse response of the ideal matched filter detector labeling all important points.



'0'



'1'

7. A bandpass signal $z(t)$ is expressed in terms of two lowpass signals, $x(t)$ and $y(t)$ of bandwidth W as $z(t) = x(t) \cos 2\pi f_c t - y(t) \sin 2\pi f_c t$. Assume that $f_c > W$. Determine the output at points A and B in Figure 2.

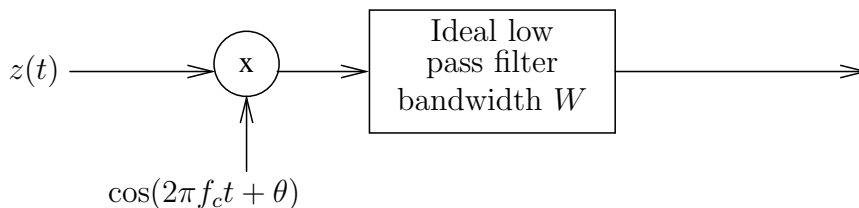


Figure 2:

8. Consider the two 8-point constellations in Figure 3.

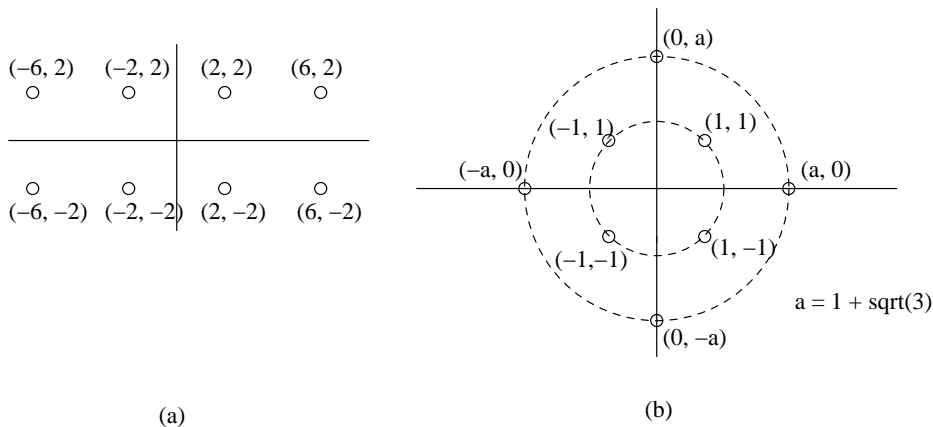


Figure 3:

- Determine the minimum distance and the average transmitted symbol energy for each constellation.
- Which of the above constellations gives lower symbol error probabilities for the same average symbol energy over an additive white Gaussian noise channel? Why?

Signal Processing

- Let $\{x(n)\}$ be a real sequence defined for $0 \leq n \leq N - 1$ with an N -point DFT $\{X(k)\}$. Let $Y(k) = X^*(k)$, $0 \leq k \leq N - 1$. Determine $\{y(n)\}$ (the N -point IDFT of $\{Y(k)\}$) in terms of $x(n)$

for $0 \leq n \leq N - 1$.

2. The transfer function of a certain LTI system is given by

$$H(z) = \frac{3}{2 + z^{-1}} + \frac{1}{1 + 2z^{-1}}.$$

Find the corresponding *stable* impulse response function $\{h(n)\}$.

3. Classify the following as true or false. Give brief explanation for your conclusion.
- (a) FIR filters require fewer computation then IIR filter for the *same* frequency response.
 - (b) Both IIR and FIR filters are *always* stable.
 - (c) FIR filter *always* have linear phase response.
4. Consider a discrete time periodic signal $x[n]$ with period N (N is even). If its Fourier Series coefficients satisfy the condition that $c_k = c_{k+N/2}$, what restriction does this place on the values of $x[n]$?
5. The impulse response of a linear time-invariant system is given as

$$h[n] = \begin{cases} 1 & n = 0. \\ -2 & n = 1, -1. \\ 4 & n = 2, -2. \\ 0 & \text{otherwise} \end{cases}$$

If the input to the above system is the sequence $\exp(j\pi n/4)$ for all n , determine the output sequence.

6. The impulse response of a linear time-invariant system is given as

$$h[n] = \begin{cases} -2 & n = 1, -1. \\ 4 & n = 2, -2. \\ 0 & \text{otherwise.} \end{cases}$$

If the input to the above system is the sequence $\cos(\pi n/4)$, determine the output sequence.

7. The transfer function of a certain LTI system is given by

$$H(z) = \frac{1 + z^{-1}}{(1 - 0.98e^{j\pi/4} z^{-1})(1 - 0.98e^{-j\pi/4} z^{-1})}.$$

Using the pole-zero diagram, make an approximate plot of $|H(e^{j\omega})|$ versus ω for $-\pi < \omega < \pi$.

Networking

1. A PBX is connected to the central digital exchange by E1 line. The total busy hour offered traffic is 30 Erlangs. If the average call duration is 3 mins, determine the following:
 - (a) Busy hour calling rate.
 - (b) If the blocking probability is $P_B = 0.1$, what is the carried traffic?
 - (c) Given the above blocking probability, compute the lost traffic?
2. Consider a satellite link and let P_u and P_d be the probability that a bit is in error in uplink and downlink respectively. Compute the overall probability that a bit is in error. Assume that the event that a bit is in error or not is independent in the uplink and downlink.
3. In stop and wait ARQ (Automatic Repeat Request), if the probability of a successful transmission of a data frame (without error) is p , compute the mean number of transmissions required to send a frame. Assume that **ack**'s or **nack**'s are NEVER lost and the occurrences of errors in the data frames are independent.