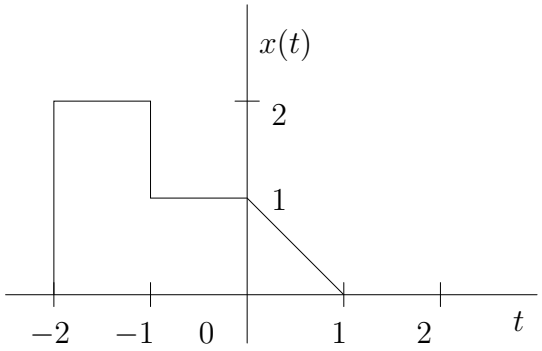
Sample Questions for MS/PhD Entrance Exams

Department of Electrical Engineering, IIT, Madras

GROUP - EE1 (Communications)

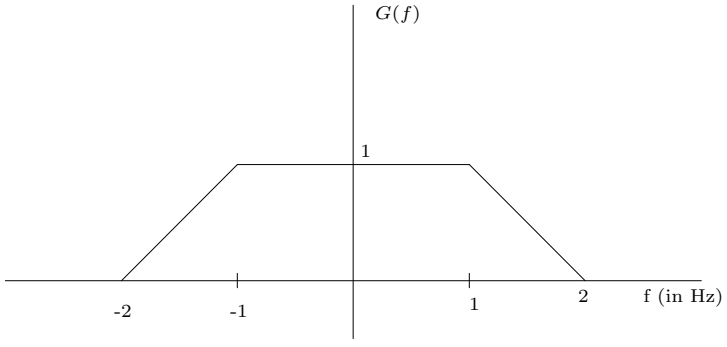
(For candidates interested in digital communications, wireless and telecom systems, speech and image processing, computer networks, optical networks and microwave communications).

1. For the signal $x(t)$ shown below sketch and label $x(2t-3)$



2. Given that X is a random variable with an uniform probability density function (pdf) between -1 and $+1$, plot the pdf of $Y = |X|$. Plot the pdf of $Z = X - 1$.

3. Given the Fourier Transform $G(f)$ (shown below) of a continuous time signal $g(t)$, answer the following:
   (a) $g(0) = ?$
   (b) $\int_{-\infty}^{\infty} |g(t)|^2 dt = ?$



4. A signal $f(t) = cos^2(100\pi t) + 3cos(80\pi t)$ is sent through an ideal low pass filter with cutoff at 60 Hz and sampled at 70 Hz to produce $g(kT)$. What are the signal components (give their frequency values) present in $g(kT)$ for $0 \leq f \leq 60$ Hz?

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

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

Shade the Region of Convergence (ROC) in the complex plane which will realise a stable impulse response.

6. 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.

7. 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, $Z\left(e^{j\omega}\right)$, of $z[n] = x(nT)$. Assume that $1/T > 2W$.

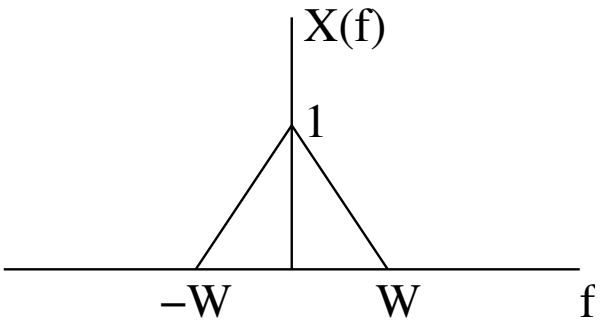


Figure 1:

8. Choose the correct answer. The input to an LTI system is $\sin 20t + \cos 10t$. The output **cannot** be

   (a) $\sin 20t$.

   (b) $\cos 20t + \sin 10t$.

   (c) $\sin 30t + \cos 10t$.

   (d) $\cos 20t$.

9. 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 $0 \leq n \leq N-1$.

10. 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 $\{h(n)\}$.

11. Choose the correct answer with brief explanation. The system $y(t) = 2 + x(t)$ with input $x(t)$ and output $y(t)$ is

(a) non-linear and time-invariant.

(b) linear and time-variant.

(c) linear and time-invariant.

(d) non-linear and time-variant.

12. A signal $x(t) = 100\cos(20000\pi t)$ is ideally sampled with a sampling period of 50 μsec. Sketch possible sequences of the sampled output.

13. 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 $-\pi < \omega < \pi$.

14. 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.

15. 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.

16. In stop and wait ARQ (Automatic Repeat Request), if the probability of a successful transmission of data frames (with out error) is p, then compute the mean number of transmissions required to send a frame. Assume that **ack**'s or **nack**'s are NEVER lost and the occurances of errors in the data frames are independent.