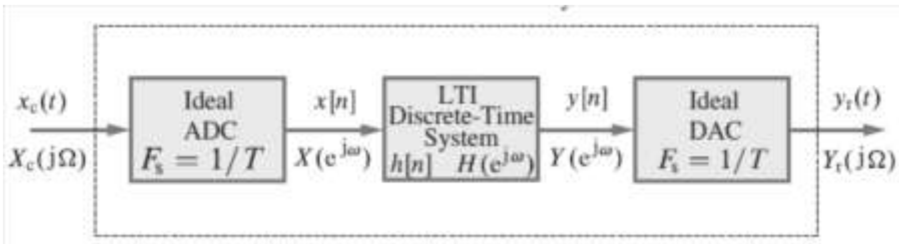
Birla Institute of Technology and Science, Pilani.
Comprehensive Examination: EEE F434 : Digital Signal Procssing
Marks: 60 AY: 2016-17, Semester: I Date: 14-Dec-2016, Wednesday
Time: 180 minutes (OPEN BOOK) Pages: 02

Q1 An analog signal $x_c(t) = 5\sin(2\pi 250t) + 10\sin(2\pi 300t)$ is to be processed using the system shown in figure 1.1 in which the sampling frequency is 1 kHz. Design a minimum-order IIR digital filter that will suppress the 300 Hz component down to 20 dB while pass the 250 Hz component with attenuation of 2 dB. Determine the system function of the filter and plot its log-magnitude response in dB. Draw the efficient filter realization structure. Justify. **15**



Q2 A system for the discrete-time spectral analysis of continuous-time signal is shown in figure 2.1. **10**

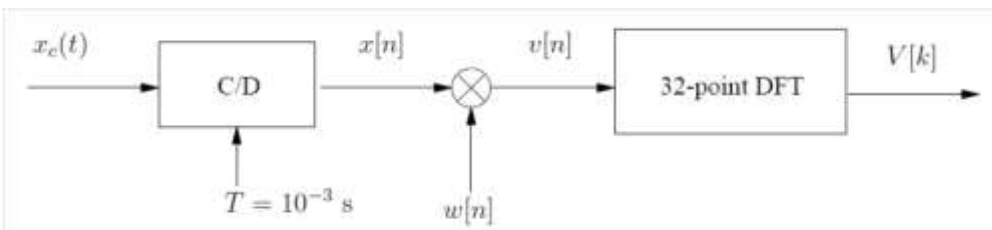


Figure 2.1: Spectral analysis system

$w[n]$ is rectangular window of length 32. $w[n] = \begin{cases} \frac{1}{32}, & 0 \le n \le 31 \\ 0 & otherwise \end{cases}$

Listed below are ten signals, at least one of which was the input $x_c(t)$. Indicate which signal(s) could have been the input $x_c(t)$ which produced the plot of $|V(k)|$ shown in dB units in Figure 2.2. As always, provide reasoning for your choice(s). Choice of inputs:

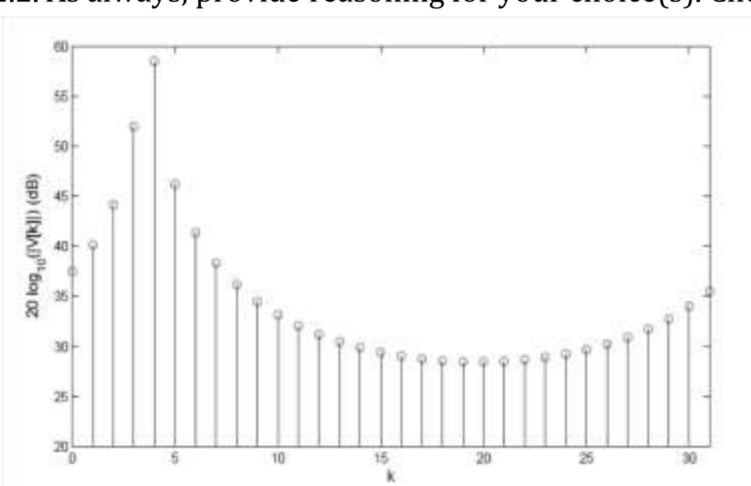


Figure 4.2: Output $|V(k)|$ in dB

1. $x_1(t) = 1000\cos(230\pi t)$
2. $x_2(t) = 1000\cos(115\pi t)$
3. $x_3(t) = 10e^{j460\pi t}$
4. $x_4(t) = 1000e^{j230\pi t}$
5. $x_5(t) = 10e^{j230\pi t}$
6. $x_6(t) = 1000e^{j250\pi t}$
7. $x_7(t) = 10\cos(250\pi t)$
8. $x_8(t) = 1000\cos(218.75\pi t)$;
9. $x_9(t) = 10e^{j200\pi t}$;
10. $x_{10}(t) = 1000\cos(230\pi t)$

Q3 The system in figure 3.1 computes an N-point (where N is an even number) DFT X[k] of an N-point sequence x[n] by decomposing x[n] into two N/2-point sequences g1[n] and g2[n], computing the N/2-point DFT's G1[k] and G2[k], and then combining these to form X[k]. If g1[n] is the even-indexed values of x[n] and g2[n] is the odd-indexed values of x[n] i.e. g1[n] = x[2n] and g2[n] = x[2n + 1] then X[k] will be the DFT of x[n]. **10**

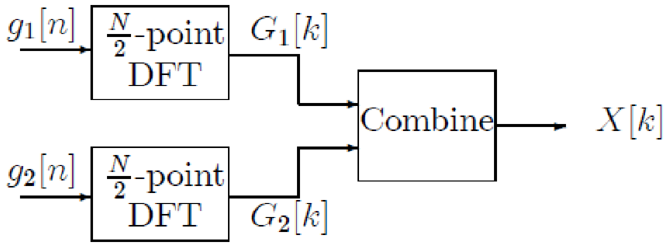


Figure 3.1

In using the system in figure 3.1 an error is made in forming g1[n] and g2[n], such that g1[n] is incorrectly chosen as the odd-indexed values and g2[n] as the even indexed values but G1[k] and G2[k] are still combined as in figure 3.1 and the incorrect sequence ˆX [k] results. Express ˆX [k] in terms of X[k]

Q4 Design a FIR linear-phase, digital filter approximating the ideal frequency response using windowing technique. Plot the magnitude and phase response of filter and advice accordingly. **15**

$$H_d(e^{j\omega}) = \begin{cases} 1, & for\ |\omega| \le \frac{\pi}{6} \\ 0, & for\ \frac{\pi}{6} \le |\omega| \le \frac{\pi}{3} \\ 1, & for\ \frac{\pi}{3} \le |\omega| \le \pi \end{cases}$$

Note: Use minimum 3 (diverse) windows, and 25-tap filter for comparison.

Q5 Design a FIR filter that completely blocks the frequency $\omega_c = \frac{\pi}{4}$, by suitable placing poles and zeros in the z-plane. The constructed filter should yield real output given that the input is real. **10**

a. Draw poles and zeros of the filter in the z-plane. Clearly state the magnitude and angle.
b. Calculate the system function $H(z)$ and frequency response $H(e^{j\omega})$
c. Sketch the magnitude response
d. If input signal to the filter is given by $x[n] = 10 + 3\cos\left(\frac{\pi}{4}n\right) + \sin\left(\frac{\pi}{3}n + \frac{\pi}{2}\right), -\infty < n < \infty$. Determine the output $y[n]$ of the filter.