Problem 4.5 in Oppenheim/Schafer/Buck
Please explain your answers! Answers without explanations will receive zero credit.

Problem 4.24 in Oppenheim/Schafer/Buck

Do the old exam problems on the next 2 pages.
ECE-410 Problem 3  (First part of an old ECE 410 exam question)
Figure 3.1 shows the Fourier transform magnitude, $|H(e^{j\omega})|$, of a DT filter.

![Filter frequency response magnitude](image)

Figure 3.1: Frequency response magnitude of DT filter for Problem ECE410-3.

(a) You need to lowpass filter a CT audio signal that is bandlimited to 24 kHz (i.e. the Fourier transform of the audio signal is zero for frequencies above 24 kHz). The filter specifications are given below:

- The filter must pass frequencies below 8000 Hz with a gain of 1 ± 0.05.
- The filter must have a gain of 0.05 or less for frequencies higher than 9000 Hz.

Consider the system shown in Figure 3.2 below. The sample frequency for this system is 48 kHz. The DT filter $H(e^{j\omega})$ has the frequency response magnitude shown in Figure 3.1.

![System diagram](image)

Figure 3.2: System for Problem ECE410-3a.

Does this system meet the specifications? Why or why not?

Justification:
Consider the signal \( x_c(t) \):

\[
x_c(t) = \cos(2\pi(1000)t) + \cos(2\pi(2500)t).
\]

This signal is processed using the system shown below:

(a) Given that \( x_c(t) \) is the signal defined above, what is the maximum value of \( T \) that will avoid aliasing in the C/D converter?

\[
T_{\text{max}} = \text{Provide a justification for your answer.}
\]

For parts b and c, assume that \( T = \frac{1}{3000} \). Do not use the \( T_{\text{max}} \) you found in part a.

(b) Make fully-labeled sketches of the Fourier transforms \( X_c(j\Omega) \), \( X(e^{j\omega}) \), \( Y(e^{j\omega}) \), and \( Y_c(j\Omega) \). Show all work, including any intermediate sketches, used to obtain these results.

(c) Determine the output signal \( y_c(t) \).