

MAT 320

Quiz 4

Fall 2025

1. At 44100 Hz sample rate, suppose we want to calculate the plucked string filter coefficients to produce a fundamental frequency (pitch) of exactly 500 Hz, by choosing parameters L for the delay in the comb filter, and a for the all-pass filter. Assuming that we are also using a low-pass filter with phase delay of one half sample, in order to find a we should use what value for δ ?
- a) 0.6 b) 0.5 c) 0.4 d) 0.7 e) 0.3
2. If a comb filter has frequency response function with peaks (maximum values) at 24 dB, and valleys (minimum values) at -6 dB, then the amplitude range of the signal is varying from low to high by a factor of about:
- a) 32 b) 128 c) 64 d) 2 e) 4
3. The low-pass filter $y_t = \frac{1}{2}(x_t + x_{t-1})$ used in the plucked string filter has which of the following properties:
- i) linear phase
ii) magnitude response $\sin(\omega/2)$
iii) allows exact frequency adjustment in plucked string filter
- a) ii) only b) i) and ii) only c) ii) and iii) only d) i) only e) all of them
4. The all-pass filter $y_t = ax_t + x_{t-1} - ay_{t-1}$ used in the plucked string filter has which of the following properties:
- i) transfer function with two complex poles
ii) magnitude response 1
iii) allows exact frequency adjustment in plucked string filter
- a) ii) only b) i) and ii) only c) i) only d) ii) and iii) only e) all of them
5. Which of the following could be the transfer function \mathcal{H} of an all-pass filter?
- a) $\frac{\frac{1}{2}z + 1}{z + \frac{1}{2}}$ b) $\frac{2 + z^{-1}}{1 + \frac{1}{2}z^{-1}}$ c) $\frac{1 + 2z^{-1}}{1 + \frac{1}{2}z^{-1}}$ d) $\frac{4 + z^{-1}}{1 + 2z^{-1}}$ e) $\frac{4z + 1}{z + 2}$
6. Which of the following could be the frequency response function $H(\omega)$ of an all-pass filter?
- a) $\frac{e^{-i\omega/2} + 3e^{i\omega/2}}{e^{i\omega/2} + \frac{1}{3}e^{-i\omega/2}}$ b) $\frac{e^{i\omega/2} + 3e^{i\omega/2}}{e^{i\omega/2} - \frac{1}{3}e^{-i\omega/2}}$ c) $\frac{e^{-i\omega/2} + 2e^{i\omega/2}}{e^{i\omega/2} + 2e^{-i\omega/2}}$ d) $\frac{e^{i\omega/2} - 2e^{i\omega/2}}{e^{-i\omega/2} + 2e^{-i\omega/2}}$
e) $\frac{4e^{-i\omega/2} + e^{i\omega/2}}{4e^{i\omega/2} - 3e^{-i\omega/2}}$
7. We used the approximation that for x close to zero: $x = \tan x = \tan^{-1} x$. For $x < 0$ which inequalities are actually true?
- a) $\tan x < x < \tan^{-1} x$ b) $x < \tan x < \tan^{-1} x$ c) $\tan^{-1} x < x < \tan x$ d) $\tan^{-1} x < \tan x < x$
e) $\tan x < \tan^{-1} x < x$
8. Suppose a comb filter has $L = 9$ and $R = 0.9$, and let $\mathbf{h} = (h_0, h_1, h_2, \dots)$ be the impulse response. Find the sum, to two decimal places. (Hint: the number $(0.9)^9$ is about 0.387.)

$$\sum_{t=0}^{\infty} h_t.$$

- a) 1.57 b) 1.71 c) 1.63 d) 1.48 e) 1.36