MAT 320 Quiz 4 Answer Sheet

Fall 2025

Quiz ID: LRP Name: ______________________

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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) $\dfrac{\frac{1}{2}z + 1}{z + \frac{1}{2}}$ b) $\dfrac{2 + z^{-1}}{1 + \frac{1}{2}z^{-1}}$ c) $\dfrac{1 + 2z^{-1}}{1 + \frac{1}{2}z^{-1}}$ d) $\dfrac{4 + z^{-1}}{1 + 2z^{-1}}$ e) $\dfrac{4z + 1}{z + 2}$

6. Which of the following could be the frequency response function $H(\omega)$ of an all-pass filter?

   a) $\dfrac{e^{-i\omega/2} + 3e^{i\omega/2}}{e^{i\omega/2} + \frac{1}{3}e^{-i\omega/2}}$ b) $\dfrac{e^{i\omega/2} + 3e^{i\omega/2}}{e^{i\omega/2} - \frac{1}{3}e^{-i\omega/2}}$ c) $\dfrac{e^{-i\omega/2} + 2e^{i\omega/2}}{e^{i\omega/2} + 2e^{-i\omega/2}}$ d) $\dfrac{e^{i\omega/2} - 2e^{i\omega/2}}{e^{-i\omega/2} + 2e^{-i\omega/2}}$

   e) $\dfrac{4e^{-i\omega/2} + e^{i\omega/2}}{4e^{i\omega/2} - 3e^{-i\omega/2}}$

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 $\mathbf{h} = (h_0, h_1, h_2, \ldots)$ 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