Test ID: TESTID Name: ____________________

MAT 320 **Quiz 5** Fall 2024

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

   Correct Answer: 0.7

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

   Correct Answer: 32

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

   Correct Answer: i) only

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

   Correct Answer: ii) and iii) only

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) $\dfrac{4z+1}{z+2}$

   Correct Answer: $\dfrac{\frac{1}{2}z+1}{z+\frac{1}{2}}$

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

   Correct Answer: $\dfrac{e^{-i\omega/2}+2e^{i\omega/2}}{e^{i\omega/2}+2e^{-i\omega/2}}$

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) $\tan x < \tan^{-1} x < x$

   Correct Answer: $\tan x < x < \tan^{-1} x$

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

Correct Answer: 1.63