Test ID: TESTID Name: _____

MAT 320 **Quiz 4** Fall 2020

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, and an all-pass fractional delay δ between 0 and 1, what should we use for L?

   a) 86 b) 85 c) 89 d) 88 e) 87

   Correct Answer: 87

2. With the same input as in the previous question, what is the value of δ?

   a) 0.6 b) 0.5 c) 0.4 d) 0.3 e) 0.7

   Correct Answer: 0.7

3. With the same input as in the previous question, what is the value of a?

   a) 0.25 b) 0.5 c) 0.45 d) 0.365 e) 0.125

   Correct Answer: 0.125

4. 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

5. 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: $\tan x < x < \tan^{-1} x$

6. 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 below, to two decimal places. (Hint: the number $(0.9)^9$ is about 0.387.)

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

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

Correct Answer: 1.63

7. Which of the following could be the transfer function $\mathcal{H}$ of an all-pass filter?

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

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

8. Which of the following could be the transfer function $\mathcal{H}$ of a low-pass filter?

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

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

9. Let $f(t)$ be the square wave with period $T = 2$ defined on its first period as 1 on the interval $[0, 1)$ and as -1 on the interval $[1, 2)$. Find the inner product $< f(t), e^{i\pi t} >$. (Use the integral definition of inner product. Don't forget the $\frac{1}{T}$ in front, and don't forget to use the conjugate.)

a) $\frac{-2i}{\pi}$ b) $\frac{2}{\pi}$ c) $\frac{2i}{\pi}$ d) 1 e) 0

Correct Answer: $\frac{-2i}{\pi}$

10. Same $f(t)$ as in the previous question. What is the inner product $< f(t), e^{i2\pi t} >$?

a) $\frac{-2i}{\pi}$ b) $\frac{2}{\pi}$ c) $\frac{2i}{\pi}$ d) 1 e) 0

Correct Answer: 0