Test ID: TESTID Name: _____

MAT 320 **Quiz 3** Spring 2020

1. Consider the digital filter F_1: $y_t = x_t - \frac{1}{4}y_{t-1}$. What is the transfer function $\mathcal{H}(z)$ for this filter?

   a) $1 - \frac{1}{4}z$ b) $1 - \frac{1}{4z}$ c) $\frac{z}{z+\frac{1}{4}}$ d) $\frac{z-\frac{1}{4}}{z}$ e) $1 - 4z$

   Correct Answer: $\frac{z}{z+\frac{1}{4}}$

2. Same filter F_1 as in the previous question. What is the frequency response $H(\omega)$ of this filter?

   a) $\frac{e^{i\omega}}{e^{i\omega}-\frac{1}{4}}$ b) $\frac{e^{i\omega}}{e^{i\omega}+\frac{1}{4}}$ c) $1 - \frac{1}{4}e^{-i\omega}$ d) $1 - 4e^{-i\omega}$ e) $\frac{e^{i\omega}-4}{e^{i\omega}}$

   Correct Answer: $\frac{e^{i\omega}}{e^{i\omega}+\frac{1}{4}}$

3. Same filter F_1 as in the previous question. What is the magnitude response $|H(\omega)|$ of this filter?

   a) $\frac{1}{|e^{i\omega}+\frac{1}{4}|}$ b) $|1 - \frac{1}{4}e^{i\omega}|$ c) $|1 - 4e^{-i\omega}|$ d) $|1 + 4e^{-i\omega}|$ e) $|\frac{e^{i\omega}-4}{e^{i\omega}}|$

   Correct Answer: $\frac{1}{|e^{i\omega}+\frac{1}{4}|}$

4. Same filter F_1 as in the previous question. Which frequency ω has the largest frequency response?

   a) $\pi/6$ b) $\pi/4$ c) $\pi/3$ d) $\pi/2$ e) $2\pi/3$

   Correct Answer: $2\pi/3$

5. Same filter F_1 as in the previous question. If the input $\mathbf{x}$ is the unit impulse signal: $(1, 0, 0, 0, \ldots)$ then what is the output value y_2? (Assume values with index less than zero are equal to 0.)

   a) $\frac{1}{16}$ b) $1 - \frac{1}{16}$ c) $-\frac{1}{16}$ d) $-\frac{1}{8}$ e) $\frac{1}{8}$

   Correct Answer: $\frac{1}{16}$

6. Consider the digital filter F_2: $y_t = \frac{1}{2}x_t + x_{t-1} - \frac{1}{2}y_{t-1}$. What is the transfer function $\mathcal{H}(z)$ for this filter?

   a) $1 - \frac{1}{2}z$ b) $1 - \frac{1}{2z}$ c) $\frac{\frac{1}{2}z+1}{z+2}$ d) $\frac{z+2}{z+\frac{1}{2}}$ e) $\frac{z+2}{2z+1}$

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

7. Same filter F_2 as in the previous question. What is the frequency response $H(\omega)$ of this filter? (Hint: Try factoring out a unit complex number from numerator and denominator.)

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

   Correct Answer: $\frac{\frac{1}{2}e^{i\frac{\omega}{2}} + e^{-i\frac{\omega}{2}}}{e^{i\frac{\omega}{2}} + \frac{1}{2}e^{-i\frac{\omega}{2}}}$

8. Same filter F_2 as in the previous question. What is the magnitude response $|H(\omega)|$ of this filter? (Hint: What is the complex conjugate of the numerator of $H(\omega)$?)

   a) $\frac{1}{|e^{i\omega}-\frac{1}{2}|}$ b) $|1 - \frac{1}{2}e^{i\omega}|$ c) 1 d) $|1 - 2e^{-i\omega}|$ e) $|\frac{e^{i\omega}-2}{e^{i\omega}}|$

   Correct Answer: 1

9. Same filter F_2 as in the previous question. How many poles does this filter have?

   a) 1 b) 3 c) 2 d) 4 e) 0

   Correct Answer: 1

10. Same filter F_2 as in the previous question. If the input $\mathbf{x}$ is the unit impulse signal: $(1, 0, 0, 0, \ldots)$ then what is the output value y_2? (Assume values with index less than zero are equal to 0.)

    a) $\frac{1}{2}$ b) $-\frac{1}{2}$ c) $+\frac{1}{4}$ d) $-\frac{3}{4}$ e) $-\frac{3}{8}$

    Correct Answer: $-\frac{3}{8}$