PRINT YOUR NAME HERE:

HONOR CODE PLEDGE: "I have neither given nor received aid on this exam, nor have I concealed any violations of the honor code." Closed book; 4 sides of 8.5×11 "cheat sheet."

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26 multiple-choice questions, worth 5 points each, and two 10-point questions. **LECTURE** Write your answer to each question in the space to the right of that question. **SESSION** NOTE: Problems vary in difficulty. Some problems are harder than others.

$\sin\frac{\pi}{6} = \cos\frac{\pi}{3} = \frac{1}{2}$; $\sin\frac{\pi}{4} = \cos\frac{\pi}{4} = \frac{\sqrt{2}}{2}$; $\sin\frac{\pi}{3} = \cos\frac{\pi}{6} = \frac{\sqrt{3}}{2}$; $\sin\frac{\pi}{2} = \cos(0) = 1$.

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1. The system (transfer) function of a LTI system described by the difference equation $y[n] + 4y[n-1] + 5y[n-2] = 2x[n] + 3x[n-1]$ is:
   (a) $\frac{2z^2+3z}{z^2+4z+5}$ **(b)** $\frac{2z+3}{z^2+4z+5}$ **(c)** $\frac{z^2+4z+5}{2z^2+3z}$ **(d)** $\frac{z^2+4z+5}{2z+3}$ **(e)** z^2+2z+2

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2. One system (transfer) function of a LTI system with zeros $\{0,1\}$ and poles $\{2,3\}$ is:
   (a) $\frac{z+1}{2z+3}$ **(b)** $\frac{z^2-5z+6}{z-1}$ **(c)** $\frac{z-1}{z^2-5z+6}$ **(d)** $\frac{z^2-5z+6}{z^2-z}$ **(e)** $\frac{z^2-z}{z^2-5z+6}$

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3. The system (transfer) function if $\{\underline{1}, 2, 3\} \rightarrow \overline{|LTI|} \rightarrow \{\underline{4}, 5, 6\}$ is:
   (a) $\frac{3z^2+2z+1}{6z^2+5z+4}$ **(b)** $\frac{6z^2+5z+4}{3z^2+2z+1}$ **(c)** $\frac{z^2+2z+3}{4z^2+5z+6}$ **(d)** $\frac{4z^2+5z+6}{z^2+2z+3}$ **(e)** $1+z+z^2$

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4. $\mathcal{Z}\{2^n u[n] + 3^n u[n]\} =:$ **(a)** $\frac{z^2-5z+6}{1}$ **(b)** $\frac{1}{z^2+5z+6}$ **(c)** $\frac{5}{z^2+5z+6}$ **(d)** $\frac{2z-5}{z^2-5z+6}$ **(e)** $\frac{2z^2-5z}{z^2-5z+6}$

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5. The system $y[n] - 5y[n-1] + 4y[n-2] = x[n] - 3x[n-1]$ has:
   ZEROS: **(a)** $\begin{smallmatrix}\{3\}\\\{1,4\}\end{smallmatrix}$ **(b)** $\begin{smallmatrix}\{0,3\}\\\{1,4\}\end{smallmatrix}$ **(c)** $\begin{smallmatrix}\{1,4\}\\\{0,3\}\end{smallmatrix}$ **(d)** $\begin{smallmatrix}\{1,4\}\\\{3\}\end{smallmatrix}$ **(e)** $\begin{smallmatrix}\textbf{NONE}\\\{1,4\}\end{smallmatrix}$
   POLES:

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6. The frequency response function of $y[n] + y[n-2] = x[n] - x[n-2]$ is:
   (a) $\tan(\omega)$ **(b)** $j\tan(\omega)$ **(c)** $\cot(\omega)$ **(d)** $-j\cot(\omega)$ **(e)** $\frac{1-e^{-j\omega}}{1+e^{-j\omega}}$

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7. If $x[n] = \cos(\frac{\pi}{2}n) + 2\cos(\pi n)$ then $y[n] = y[n-1] + x[n] + x[n-1] =:$
   (a) $\cos(\frac{\pi}{2}n)$ **(b)** $\cos(\pi n)$ **(c)** $2\cos(\frac{\pi}{2}n) + 3\cos(\pi n)$ **(d)** $\sin(\frac{\pi}{2}n)$ **(e)** 0

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8. Which signal is eliminated by $y[n] - y[n-1] = x[n] + x[n-1] + x[n-2]$:
(a) 1 **(b)** $\cos(\frac{\pi}{4}n)$ **(c)** $\cos(\frac{\pi}{3}n)$ **(d)** $\cos(\frac{\pi}{2}n)$ **(e)** $\cos(\frac{2\pi}{3}n)$

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9. Which of these filters eliminates 375 Hz in a signal sampled at 1 kHz? $h[n] =$:
(a) $\{1, 1, 1\}$ **(b)** $\{1, -1, 1\}$ **(c)** $\{1, 0, 1\}$ **(d)** $\{1, 0, -1\}$ **(e)** $\{1, \sqrt{2}, 1\}$

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10. Correlation of $\cos(2\pi\frac{3}{25}n)$ and $\sin(2\pi\frac{3}{25}n)$ is: **(a)** 0 **(b)** 1 **(c)** $\sqrt{2}$ **(d)** -1 **(e)** $-\sqrt{2}$

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11. If $6/[(z+1)(z-2)] = A/(z-2) + B/(z+1)$ then $A =$: **(a)** 1 **(b)** -1 **(c)** 2 **(d)** -2 **(e)** 6

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12. If $H(z) = 6/[(z+1)(z-2)] = A/(z-2) + B/(z+1)$ then $h[n] = \mathcal{Z}^{-1}\{H(z)\} =$:
(a) $2^n u[n] + (-1)^n u[n]$ **(b)** $2^n u[n] - (-1)^n u[n]$ **(c)** $2(2^n)u[n] + 2(-1)^n u[n]$
(d) $2(2^n)u[n] - 2(-1)^n u[n]$ **(e)** $2^n u[n] + 2(-1)^n u[n] - 3\delta[n]$.

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13. If $H(z) = (6z)/(z^2 - 9)$ then $h[n] =$: **(a)** 0 for n odd **(b)** 0 for n even **(c)** never 0
(d) 0 for n is multiple of 3 **(e)** 0 for n not a multiple of 3

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14. $\frac{1}{2}(1+j)(j)^n + \frac{1}{2}(1-j)(-j)^n$ can be rewritten as:
(a) $\cos(\frac{\pi}{4}n + \frac{\pi}{2})$ **(b)** $\cos(\frac{\pi}{2}n + \frac{\pi}{4})$ **(c)** $\sqrt{2}\cos(\frac{\pi}{4}n + \frac{\pi}{2})$ **(d)** $\sqrt{2}\sin(\frac{\pi}{2}n)$ **(e)** $\sqrt{2}\cos(\frac{\pi}{2}n + \frac{\pi}{4})$

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15. A LTI system with a zero at $\{-0.95\}$ and pole at $\{0.95\}$ acts as what kind of filter?
(a) High-pass **(b)** Low-pass **(c)** Band-pass **(d)** Band-reject

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16. Which of these filters has DC gain=0 and $H(\omega = \pi) = 4$?
(a) $\{1, 1, 1\}$ **(b)** $\{1, -1, 1\}$ **(c)** $\{1, 2, 1\}$ **(d)** $\{1, -2, 1\}$ **(e)** $\{1, \sqrt{2}, 1\}$

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17. The impulse response if $\delta[n] + 2^n u[n] \rightarrow \overline{|LTI|} \rightarrow \{\underline{2}, -2\}$ is: **(a)** $\delta[n] - 2^n u[n]$
(b) $(\frac{1}{2})^n u[n]$ **(c)** $2(\frac{1}{2})^n u[n] - 2(\frac{1}{2})^{n-1} u[n-1]$ **(d)** $\{\underline{1}, -2\}$ **(e)** $2\delta[n] - 2(2^{n-1})u[n-1]$

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18. The impulse response if $3^n u[n] \rightarrow \overline{|LTI|} \rightarrow \delta[n]$ is:
(a) $(\frac{1}{3})^n u[n]$ **(b)** $(-\frac{1}{3})^n u[n]$ **(c)** $\{\underline{1}, -3\}$ **(d)** $\{\underline{1}, 3\}$ **(e)** $-3^n u[n]$

19. The impulse response if $2^n u[n] + 4^n u[n] \rightarrow \overline{|LTI|} \rightarrow \delta[n]$ is:
(a) $(\frac{1}{2})^n u[n] + (\frac{1}{4})^n u[n]$ **(b)** $\{1, 2, 4\}$ **(c)** $\{1, -2, -4\}$ **(d)** $C3^n$ for $n > 3$ for some C

20. The system having frequency response $[2e^{-j\omega}]/[1 + 3e^{-j2\omega}]$ is:
(a) $y[n-1] = \frac{1}{2}x[n] + \frac{3}{2}x[n-2]$ **(b)** $y[n] + 3y[n-2] = 2x[n-1]$ **(c)** $y[n] = x[n] + 3x[n-2]$
(d) $y[n] + 3y[n-1] = 2x[n]$ **(e)** $y[n] + 3y[n-1] = 2x[n-1]$

21. Let $y[n] = x[n] + 2x[n-1] + 3x[n-2]$. Which statement **ISN'T** true:
(a) The impulse response is absolutely summable **(b)** The system is stable
(c) The system has poles only at $z = 0$ **(d)** System is AR **(e)** System is FIR

22. Which system has gain function $\sqrt{(3 + 4\cos\omega)^2 + 16\sin^2\omega} / \sqrt{(1 + 2\cos\omega)^2 + 4\sin^2\omega}$?
(a) $3y[n] + 4y[n-1] = x[n] + 2x[n-1]$ **(b)** $y[n] + 2y[n-1] = 3x[n] + 4x[n-1]$
(c) $4y[n] + 3y[n-1] = 2x[n] + x[n-1]$ **(d)** $2y[n] + y[n-1] = 4x[n] + 3x[n-1]$
(e) $y[n] = x[n] + x[n-1]$

23. Two systems are: $y[n] - 5y[n-1] + 6y[n-2] = x[n]$ and $y[n] = x[n] - 3x[n-1]$.
Their series or cascade connection has impulse response $h[n] =$:
(a) $\{1, -2\}$ **(b)** $\{1, -3\}$**(c)** $2^n u[n]$ **(d)** $3^n u[n]$ **(e)** $3(2)^n u[n] - 3^n u[n]$

24. Which system eliminates $3\cos(\frac{\pi}{2}n) + 4\cos(\pi n)$? **(a)** $y[n] = x[n] + x[n-1]$
(b) $y[n] = x[n] + x[n-2]$ **(c)** $y[n] = x[n] + x[n-1] + x[n-2]$ **(d)** $y[n] = x[n] - x[n-4]$

25. A system with zeros $\{e^{j\pi/8}, e^{j\pi/4}, 1, e^{j7\pi/4}, e^{j15\pi/8}\}$ acts as what kind of filter?
(a) High-pass **(b)** Low-pass **(c)** Band-pass **(d)** Band-reject

26. The purpose of an antialias filter in a DSP system is: **(a)** Increase the sampling rate
(b) Sharpen the signal **(c)** Ensure there are no frequencies above the Nyquist rate
(d) Eliminate noise **(e)** Eliminate any TV series starring Jennifer Garner

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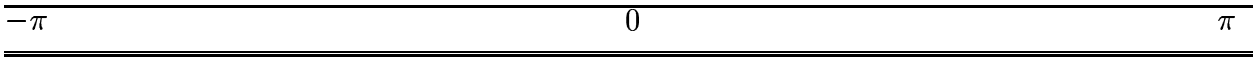
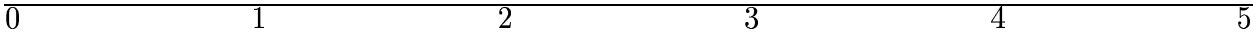
(10) 27. A LTI system has $H(z) = [(z - e^{j2\pi/3})(z - e^{-j2\pi/3}]/[(z - 0.99e^{j\pi/3})(z - 0.99e^{-j\pi/3})]$. Sketch the relative magnitude of its frequency response (i.e., gain) on the plot below.



(10) 28. (Period=8 and even) $x[n] \rightarrow \underline{|y[n] = x[n] - x[n-2] + x[n-4] - x[n-6]|} \rightarrow y[n]$

Make a stem plot of $y[n]$ on the axis below. Don't worry about the vertical scale.
HINT: $(z^6 - z^4 + z^2 - 1)(z^2 + 1) = (z^8 - 1)$. What do the zeros do to periodic $x[n]$?



DID YOU REMEMBER TO SIGN THE HONOR PLEDGE?