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; 2 sides of 8.5×11 "cheat sheet."

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20 multiple-choice questions, worth 4 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.

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

For #1-#3: L=Linear and TI=Time-Invariant.

1. The system $y[n] = \sin(3n)x[n]$ is:
(a) L AND TI **(b)** L NOT TI **(c)** TI NOT L **(d)** NOT L;NOT TI **(e)** Can't tell

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2. The system $y[n] = x[n]x[n-2]$ is:
(a) L AND TI **(b)** L NOT TI **(c)** TI NOT L **(d)** NOT L;NOT TI **(e)** Can't tell

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3. The system $y[n] = 3x[n] + 4x[n-1]$ is:
(a) L AND TI **(b)** L NOT TI **(c)** TI NOT L **(d)** NOT L;NOT TI **(e)** Can't tell

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For #4-#6: We observe the following about an LTI system:
The response to $\{\underline{1}, 1, 1\}$ is $\{\underline{2}, 1, 1, -1\}$. The response to $\{\underline{1}, 2, 3\}$ is $\{\underline{2}, 3, 4, -3\}$.

4. The response to $\{\underline{2}, 3, 4\}$ is:
(a) $\{\underline{2}, 5, 7, -5\}$ **(b)** $\{\underline{2}, -1, 0, 0\}$ **(c)** $\{\underline{4}, 4, 5, -4\}$ **(d)** $\{\underline{10}, 9, 11, -9\}$ **(e)** $\{\underline{2}, 0, 0, -1\}$

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5. The response to $\{\underline{5}, 7, 9\}$ is:
(a) $\{\underline{2}, 5, 7, -5\}$ **(b)** $\{\underline{2}, -1, 0, 0\}$ **(c)** $\{\underline{4}, 4, 5, -4\}$ **(d)** $\{\underline{10}, 9, 11, -9\}$ **(e)** $\{\underline{2}, 0, 0, -1\}$

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6. The impulse response is:
(a) $\{\underline{2}, 5, 7, -5\}$ **(b)** $\{\underline{2}, -1, 0, 0\}$ **(c)** $\{\underline{4}, 4, 5, -4\}$ **(d)** $\{\underline{10}, 9, 11, -9\}$ **(e)** $\{\underline{2}, 0, 0, -1\}$

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7. The response of $y[n] = x[n] + x[n-1]$ to $x[n] = \cos(\frac{\pi}{2}n)$ is:
(a) $2\cos(\frac{\pi}{2}n)$ **(b)** $\sqrt{2}\cos(\frac{\pi}{2}n)$ **(c)** $\sin(\frac{\pi}{2}n)$ **(d)** $\sqrt{2}\cos(\frac{\pi}{2}n + \frac{\pi}{4})$ **(e)** $\sqrt{2}\cos(\frac{\pi}{2}n - \frac{\pi}{4})$

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8. At what frequency is the response of $y[n] = x[n] + x[n-1]$ zero?
(a) 0 **(b)** $\pi/4$ **(c)** $\pi/2$ **(d)** $3\pi/4$ **(e)** π

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9. The convolution $\{1, 2\} * \{3, 4\} =$
(a) $\{5, 6\}$ **(b)** $\{3, 5, 8\}$ **(c)** $\{3, 10, 8\}$ **(d)** $\{3, 11, 8\}$ **(e)** $\{3, 8\}$

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10. Continuous-time $\cos(2\pi 300t)$ is sampled every 0.001 second.
The resulting discrete-time signal has the same line spectrum as
which TWO of the following signals sampled every 0.001 second?
(a) $\cos(2\pi 700t)$ **(b)** $\cos(2\pi 1200t)$ **(c)** $\cos(2\pi 1300t)$ **(d)** $\cos(2\pi 1600t)$ **(e)** $2\cos(2\pi 2000t)$

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11. $x(t) = 2.5\cos(2\pi 100t) + 10\sin(2\pi 500t) + 11\cos(2\pi 750t + \frac{\pi}{2})$ is sampled.
The sampled $x(t)$ will have only two distinct frequencies if the sampling frequency is:
(a) 110 Hz **(b)** 200 Hz **(c)** 860 Hz **(d)** 1000 Hz **(e)** 1700 Hz

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For #12-#14: C=Causal and S=BIBO stable. The systems are all LTI.

12. If bounded $x[n] \rightarrow \boxed{|LTI|} \rightarrow \sum_{i=-\infty}^{n}(0.8)^{n-i}x[i]$, the system is:
(a) C AND S **(b)** C NOT S **(c)** S NOT C **(d)** NOT C NOT S **(e)** Can't tell.

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13. If $(\delta[n] + \delta[n-1]) \rightarrow \boxed{|LTI|} \rightarrow \delta[n+1] + \delta[n] + e^{2(n-1)}u[n-1] + e^{2(n-2)}u[n-2]$, then:
(a) C AND S **(b)** C NOT S **(c)** S NOT C **(d)** NOT C NOT S **(e)** Can't tell.

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14. If $10^6\delta[n+200] \rightarrow \boxed{|LTI|} \rightarrow \cos(2\pi 0.1n)u[n-10000]$, then the system is:
(a) C AND S **(b)** C NOT S **(c)** S NOT C **(d)** NOT C NOT S **(e)** Can't tell.

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15. If $(\delta[n] + 0.5\delta[n-2]) \rightarrow \boxed{|LTI|} \rightarrow \{\underline{1}, -1, 0, -0.5, -0.25\}$, the impulse response is:
(a) $\{\underline{1}, 1\}$ **(b)** $\{\underline{1}, -1, -0.5\}$ **(c)** $\{\underline{1}, -1, 0, -0.5, -0.25\}$
(d) $\{\underline{1}, -1.5, 0.25, 0.125\}$ **(e)** $\{\underline{1}, -1, -1, -0.5\}$

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16. Two LTI systems have impulse responses $\{\underline{1}, 1, -1, -1\}$ and $\{\underline{0}, 2, 4, 6\}$.
Their cascade or series connection:
(a) Has impulse response $\{\underline{1}, 3, 3, 5\}$ **(b)** Is also LTI **(c)** Is not BIBO stable **(d)** Alters frequencies of the input **(e)** Has the same impulse response as their parallel connection.

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17. A real $x[n]$ with period=25 has DFT $X(5) = 2e^{j\pi/2}$ and
$X(k) = 0$ for all **other** $0 \leq k \leq 13$. Then:
(a) $x[n]$ has a component at frequency $\pi/2$ **(b)** $x[n] = 2\cos(\pi n)$ **(c)** $x[n] = 4\cos(0.4\pi n)$
(d) $x[n] = 4\sin(0.4\pi n + \frac{\pi}{2})$ **(e)** $X(20) = 2e^{-j\pi/2}$

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18. Let $x[n] = \cos(2\pi\frac{3}{25}n)$ and $y[n] = \cos(2\pi\frac{7}{25}n)$. Their correlation is:
(a) non-zero imaginary **(b)** always zero **(c)** a nonzero multiple of $\frac{2\pi}{25}$ **(d)** product of the powers of $x[n]$ and $y[n]$ **(e)** the sum of DFT coefficients of $x[n]$ and $y[n]$

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19. Let $y[n] = x[n-3]$ for all n. Then their DFTs $X(k)$ and $Y(k)$ are related by:
(a) $Y(k) = X(k-3)$ **(b)** $Y(k) = e^{j2\pi 3k/25}X(k)$ **(c)** $|Y(k)| > |X(k)|$
(d) $Y(k) = e^{-j2\pi 3k/25}X(k)$ **(e)** $y[n]$ no longer has period 25

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20. $x[n] = \cos(2\pi\frac{10}{25}n)$ is input into a LTI system with frequency response $1+0.5e^{j\omega}+1e^{j2\omega}$.
The frequency of the output is:
(a) 0.8π **(b)** $1 + 0.5e^{j2\pi 10/25} + 1e^{j4\pi 10/25}$ **(c)** $|1 + 0.5e^{0.8\pi} + e^{1.6\pi}|$ **(d)** 2.5 **(e)** 0

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(10) 21. The continuous-time signal $\cos(2\pi 1000t) + 2\cos(2\pi 2000t)$ is sampled at 3500 Hz. Sketch **carefully** the line spectrum of the **sampled** signal. Watch line heights!

-5	-4	-3	-2	-1	0	1	2	3	4	5	f (kHz)

(10) 22. Let $x[n] \rightarrow \overline{|h[n]|} \rightarrow y[n]$. Prove if $x[n]$ is periodic with period N, then $y[n]$ is also periodic with period N.

DID YOU REMEMBER TO SIGN THE HONOR PLEDGE?