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."

SIGN YOUR NAME HERE:

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30 multiple-choice questions, worth 5 points each, for a total of 150 points. **LECTURE**
Write your answer to each question in the space to the right of that question. **SESSION**
Do NOT write your answers on a separate sheet of paper or in a blue book.
NOTE: No partial credit if an error on one problem leads to an error on another problem.
NOTE: Multiple-choice problems vary in difficulty. Some problems are harder than others.
NOTE: Don't spend too much time on any one problem! If trouble, go on to another one.

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

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1. The z-transform of $\{\underline{1}, 2, 3\} + (4)^n u[n]$ is:
(a) $\frac{2z^3+2z^2+5z-12}{z^3-4z^2}$ **(b)** $1 + 2z^{-1} + 3z^{-2}$ **(c)** $z^2 + 2z + 3 + \frac{z}{z-4}$ **(d)** $\frac{2z^3-2z^2-5z-12}{z^3-4z^2}$

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2. The z-transform of $(3)^n u[n] + (5)^n u[n]$ is:
(a) $\frac{1}{z^2-8z+15}$ **(b)** $\frac{2z^2-8z}{z^2-8z+15}$ **(c)** $\frac{2z-8}{z^2-8z+15}$ **(d)** $\frac{z^2-8z}{z^2-8z+15}$ **(e)** $\frac{z-8}{z^2-8z+15}$

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3. $(1+j)(1+j\sqrt{3})^n + (1-j)(1-j\sqrt{3})^n =$: **(a)** $\sqrt{2}(2)^{n+1}\cos(\frac{\pi}{3}n + \frac{\pi}{4})$
(b) $2(\sqrt{2})^n \cos(\frac{\pi}{3}n + \frac{\pi}{4})$ **(c)** $\sqrt{2}(2)^{n+1}\cos(\frac{\pi}{4}n + \frac{\pi}{3})$ **(d)** $2(\sqrt{2})^n \cos(\frac{\pi}{4}n + \frac{\pi}{3})$

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

For problems #5-6 the system is described by $y[n] = x[n] + 4x[n-1] + 3x[n-\underline{\mathbf{3}}]$.

5. The response to $x[n] = \cos(\frac{\pi}{3}n)$ is $y[n] =$:
(a) 0 **(b)** $2\sqrt{3}\cos(\frac{\pi}{3}n - \frac{\pi}{2})$ **(c)** $\sqrt{3}\cos(\frac{\pi}{3}n - \frac{\pi}{3})$ **(d)** $\frac{1}{2}\cos(\frac{\pi}{3}n + \frac{\pi}{3})$ **(e)** ∞

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6. The response to $x[n] = 1 + 2\cos(\frac{\pi}{2}n) + 3\cos(\pi n)$ is $y[n] =$:
(a) 0 **(b)** $8 + 2\sqrt{2}\cos(\frac{\pi}{2}n - \frac{\pi}{4}) - 18\cos(\pi n)$ **(c)** $4\sqrt{2}\cos(\frac{\pi}{2}n - \frac{\pi}{4}) - 18\cos(\pi n)$
(d) $8 + 4\sqrt{2}\cos(\frac{\pi}{2}n + \frac{\pi}{4}) - 18\cos(\pi n)$ **(e)** $8 + 4\sqrt{2}\cos(\frac{\pi}{2}n - \frac{\pi}{4})$

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7. Which of these signals is eliminated by $y[n] = x[n] + x[n-1] + x[n-2]$:
(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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8. Which of these filters eliminates 125 Hz in a signal sampled at 1000 Hz? $h[n] =$:
(a) $\{1, 1, 1\}$ **(b)** $\{1, -1, 1\}$ **(c)** $\{1, \sqrt{2}, 1\}$ **(d)** $\{1, -\sqrt{2}, 1\}$ **(e)** $\{1, 0, -1\}$

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For problems #9-#12: An LTI system has transfer function $H(z) = \frac{6z}{(z-2)(z-3)}$.

9. Difference equation is: **(a)** $y[n] + 5y[n-1] + 6y[n-2] = 6x[n-2]$
(b) $y[n] + 5y[n-1] + 6y[n-2] = 6x[n-1]$ **(c)** $y[n] + 5y[n-1] + 6y[n-2] = 6x[n]$
(d) $y[n] - 5y[n-1] + 6y[n-2] = 6x[n-1]$ **(e)** $y[n] - 5y[n-1] + 6y[n-2] = 6x[n]$

10. Response to $\cos(\pi n)$: **(a)** 0 **(b)** $\cos(\pi n)$ **(c)** $\frac{1}{2}\cos(\pi n)$ **(d)** $\frac{1}{2}\cos(\pi n - \pi)$ **(e)** $2\cos(\pi n)$

11. The impulse response $h[n]$ is: **(a)** $3^n u[n] + 2^n u[n]$ **(b)** $2^n u[n] - 3^n u[n]$ **(c)** $\delta[n] - 3(2)^n u[n] + 2(3)^n u[n]$ **(d)** $6\delta[n] - 4(2)^n u[n] - 2(3)^n u[n]$ **(e)** $6(3)^n u[n] - 6(2)^n u[n]$.

12. Output $y[n] = 0$ for $n \geq 2$ for input $x[n] =$:
(a) $2^n u[n] + 3^n u[n]$ **(b)** $\{\underline{2}, 3\}$ **(c)** $\{\underline{1}, 5, 6\}$ **(d)** $\{\underline{1}, -5, 6\}$ **(e)** No non-zero $x[n]$

For problems #13-16: $5y[n] + 3y[n-1] + y[n-2] = 7x[n] + 6x[n-1] - x[n-2]$.

13. TRANSFER FUNCTION $H(z) =$: **(a)** $\frac{7z^2+6z-1}{z^2+3z+5}$ **(b)** $\frac{5z^2+3z+1}{7z^2+6z-1}$ **(c)** $\frac{7z^2+6z-1}{5z^2+3z+1}$ **(d)** $\frac{z^2+3z+5}{-z^2+6z+7}$ **(e)** $\frac{-z^2+6z+7}{z^2+3z+5}$

14. Response to $x[n] = 2\cos(\omega n)$ is $y[n] = 0$ for $\omega =$: **(a)** 0 **(b)** $\frac{\pi}{3}$ **(c)** $\frac{\pi}{2}$ **(d)** $\frac{2\pi}{3}$ **(e)** π

15. The frequency response function is $H(\omega) =$:
(a) $\frac{6+7e^{j\omega}-e^{-j\omega}}{3+e^{j\omega}+5e^{-j\omega}}$ **(b)** $\frac{3+5e^{j\omega}+e^{-j\omega}}{6+7e^{j\omega}-e^{-j\omega}}$ **(c)** $\frac{6+7e^{j\omega}-e^{-j\omega}}{3+5e^{j\omega}+e^{-j\omega}}$ **(d)** $\frac{3+e^{j\omega}+5e^{-j\omega}}{6-e^{j\omega}+7e^{-j\omega}}$ **(e)** $\frac{6-e^{j\omega}+7e^{-j\omega}}{3+e^{j\omega}+5e^{-j\omega}}$

16. Response to $x[n] = 9 + 2\cos(\frac{\pi}{2}n) + 3\cos(\pi n)$ is $y[n] =$: **(a)** 0 **(b)** $12 + 4\cos(\frac{\pi}{2}n)$
(c) $\frac{27}{4} + 10\cos(\frac{\pi}{2}n + 37^o) + \frac{9}{2}\cos(\frac{\pi}{2}n)$ **(d)** $10\cos(\frac{\pi}{2}n + 37^o) + 3\cos(\frac{\pi}{2}n)$ **(e)** ∞

17. The zeros of a LTI system with impulse response $h[n] = \frac{1}{4}((0.9)^n + (-0.4)^n)u[n]$ are:
(a) $\{0.9, -0.4\}$ **(b)** $\{-0.9, 0.4\}$ **(c)** $\{0, 0.25\}$ **(d)** $\{0.5\}$ **(e)** $\{0, 1.3\}$

18. An LTI system with a zero at $\{0.25\}$ and poles at $\{0.5, -0.25\}$ has impulse response
(a) $\frac{1}{3}(0.5)^n u[n]$ **(b)** $\frac{1}{2}(0.5)^n u[n] - (-0.25)^n u[n]$ **(c)** $\frac{1}{3}((0.5)^n + (0.25)^n)u[n]$
(d) $\frac{1}{3}(0.5)^{n-1}u[n-1] + \frac{2}{3}(-0.25)^{n-1}u[n-1]$ **(e)** $\frac{1}{3}(0.5)^n u[n] + \frac{2}{3}(-0.25)^n u[n]$

19. The filter eliminating 200 Hz and 400 Hz if sampling rate=1200 Hz is $h[n] =$:
(a) $\{\underline{1}, 0, 1, 0, 1\}$ **(b)** $\{\underline{1}, 0, 1.25, 0, 1\}$ **(c)** $\{\underline{1}, 0, 1.75, 0, 1\}$ **(d)** $\{\underline{1}, .27, -1.46, .27, 1\}$

20. Which eliminates 0-mean periodic signals with period=$\frac{1}{125}$ sec sampled at 1 kHz:
(a) $y[n] = x[n] + x[n-1] + x[n-2] + x[n-3]$ **(b)** $y[n] = \sum_{i=0}^{7} x[n-i]$
(c) $y[n] + y[n-1] + y[n-2] + y[n-3] = x[n]$ **(d)** $\sum_{i=0}^{7} y[n-i] = x[n]$

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21. The stable $h[n]$ whose frequency response has sharp peaks at $\omega = \pm\frac{\pi}{3}$ and $\pm\frac{2\pi}{3}$ is:
(a) $(.9)\cos(\frac{\pi}{3}n)u[n] + (.9)\cos(\frac{2\pi}{3}n)u[n]$ **(b)** $(.9)^n\cos(\frac{\pi}{3}n)u[n] + (.9)^n\cos(\frac{2\pi}{3}n)u[n]$
(c) $\{\underline{1}, 0, 1, 0, 1\}$ **(d)** $\{\underline{1}, 0, 1.25, 0, 1\}$ **(e)** $\{\underline{1}, 0, 1.75, 0, 1\}$

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22. The system whose frequency response is $H(e^{j\omega}) = j\tan\omega$ is:
(a) $y[n] + y[n-1] = x[n] - [n-1]$ **(b)** $y[n] - y[n-1] = x[n] + [n-1]$
(c) $y[n] + y[n-2] = x[n] - [n-2]$ **(d)** $y[n] - y[n-2] = x[n] + [n-2]$

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23. If input $2^n u[n] + 3^n u[n] \rightarrow \overline{|LTI|} \rightarrow 4^n u[n]$ then the system has:
(a) Zeros$\{2, 3\}$ **(b)** Poles$\{2, 3\}$ **(c)** Zero$\{4\}$ **(d)** Pole$\{4\}$ **(e)** [(a)+(d)] **(f)** [(b)+(c)]

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24. Simplest system such that $2^n u[n] + 3^n u[n] \rightarrow \overline{|LTI|} \rightarrow 0 \text{ for } n \geq 2$ is $h[n] =$:
(a) $2^n u[n] + 3^n u[n]$ **(b)** $\{\underline{2}, 3\}$ **(c)** $\{\underline{1}, 5, 6\}$ **(d)** $\{\underline{1}, -5, 6\}$ **(e)** No non-zero $h[n]$

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25. $y[n] = x[n] + x[n-1] + x[n-2] + x[n-3]$ is best described as: **(a)** Band-pass filter
(b) Low-pass filter with cutoff $\frac{\pi}{4}$ **(c)** Low-pass filter with cutoff $\frac{3\pi}{4}$
(d) High-pass filter with cutoff $\frac{\pi}{4}$ **(e)** High-pass filter with cutoff $\frac{3\pi}{4}$

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26. y[n]+2(.9)y[n-1]+2(.9)^{2}y[n-2]+(.9)^{3}y[n-3]=x[n]-x[n-1]+x[n-2]-x[n-3]+x[n-4]-x[n-5] is a:
(a) Low-pass filter with cutoff $\frac{\pi}{4}$ **(b)** Low-pass filter with cutoff $\frac{3\pi}{4}$ **(c)** Band-pass
(d) High-pass filter with cutoff $\frac{\pi}{4}$ **(e)** High-pass filter with cutoff $\frac{3\pi}{4}$

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27. The inverse filter $g[n]$ for $h[n] = 2^n u[n] + 4^n u[n]$ such that $g[n] * h[n] = \delta[n]$ is:
(a) $[(-2)^n + (-4)^n]u[n]$ **(b)** $\frac{1}{2}[(4)^n - (2)^n]u[n]$ **(c)** $\{\underline{1}, -6, 8\}$
(d) $\{\underline{1}, -6, 8\} * (6)^n u[n]$ **(e)** $\{\underline{\frac{1}{2}}, -3, 4\} * (3)^n u[n]$

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28. Which one of these systems has a stable and causal inverse filter? $h[n] =$:
(a) $2^n u[n] + 3^n u[n]$ **(b)** $\{\underline{1}, 5, 6\}$ **(c)** $\{\underline{6}, 5, 1\}$ **(d)** $\{\underline{1}, 2\}$ **(e)** $\{\underline{1}, 2.5, 1\}$

For problems #29-30: All signals $x[n]$ and $h[n]$ have finite durations>1;
For problems #29-30: Neglect scale factor ambiguities: knowing cx[n] suffices.

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29. $x[n] \rightarrow \overline{|h[n]|} \rightarrow \{\underline{1}, 2, 1\}$. Then $x[n] =$:
(a) $\{\underline{1}, 2, 1\}$ **(b)** $\{\underline{1}, 1\}$ **(c)** $\{\underline{1}, -1\}$ **(d)** $\{\underline{1}, 2\}$ **(e)** No way to tell

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30. If $x[n] \rightarrow \overline{|h_1[n]|} \rightarrow \{\underline{1}, 5, 6\}$ and $x[n] \rightarrow \overline{|h_2[n]|} \rightarrow \{\underline{1}, 6, 8\}$. Then $x[n] =$:
(a) $\{\underline{1}, 2, 1\}$ **(b)** $\{\underline{1}, 1\}$ **(c)** $\{\underline{1}, -1\}$ **(d)** $\{\underline{1}, 2\}$ **(e)** No way to tell

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DID YOU REMEMBER TO SIGN THE HONOR PLEDGE?