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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:

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: 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.

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

For problems #1-#3: An LTI system has transfer function $H(z)=\frac{z}{(z-1)(z-2)}$.

1. Difference equation is: **(a)** $y[n]-3y[n-1]+2y[n-2]=x[n-2]$
(b) $y[n]-3y[n-1]+2y[n-2]=x[n-1]$ **(c)** $y[n]-3y[n-1]+2y[n-2]=x[n]$
(d) $y[n]+3y[n-1]+2y[n-2]=x[n-1]$ **(e)** $y[n]+3y[n-1]+2y[n-2]=x[n]$

2. Response to $\cos(\pi n)$: **(a)** 0 **(b)** $\cos(\pi n)$ **(c)** $\frac{1}{6}\cos(\pi n)$ **(d)** $\frac{1}{6}\cos(\pi n-\pi)$ **(e)** $6\cos(\pi n)$

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

For problems #4-#6: An LTI system has zeros $\{3,4\}$ and poles $\{1,2\}$.

4. Transfer function is: **(a)** $\frac{(z-1)(z-2)}{(z-3)(z-4)}$ **(b)** $\frac{(z-3)(z-4)}{(z-1)(z-2)}$ **(c)** $\frac{z^2+3z+4}{z^2+z+2}$ **(d)** $\frac{z^2+z+2}{z^2+3z+4}$

5. Difference equation is: **(a)** $y[n]-3y[n-1]+2y[n-2]=x[n]-7x[n-1]+12x[n-2]$
(b) $y[n]+2y[n-1]=3x[n]+4x[n-1]$ **(c)** $3y[n]+4y[n-1]=x[n]+2x[n-1]$
(d) $y[n]-7y[n-1]+12y[n-2]=x[n]-3x[n-1]+2x[n-2]$

6. Response to $\{1,-3,2\}$: **(a)** 0 **(b)** $\delta[n]$ **(c)** $\{3,4\}$ **(d)** $\{1,-7,12\}$ **(e)** $2u[n]-3(2)^n u[n]$

For problems #7-#9: $\{1,0,2\}\rightarrow$ **LTI** $\rightarrow\{1,-1,1\}$.

7. Response to $\{1,1,2,2\}$: **(a)** $\delta[n]$ **(b)** $\{1,0,0,1\}$ **(c)** $\{1,1,4,3,4,2\}$ **(d)** $\{1,2,3,4\}$

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8. Response to $\cos(\frac{\pi}{3}n)$: **(a)** 0 **(b)** $\cos(\frac{\pi}{3}n)$ **(c)** $\sin(\frac{\pi}{3}n)$ **(d)** $2\cos(\frac{\pi}{3}n - \frac{\pi}{6})$ **(e)** $3\cos(\frac{\pi}{3}n)$

9. Response to $\cos(\frac{\pi}{2}n)$: **(a)** 0 **(b)** $\cos(\frac{\pi}{2}n)$ **(c)** $\sin(\frac{\pi}{2}n)$ **(d)** $2\cos(\frac{\pi}{2}n - \frac{\pi}{6})$ **(e)** $3\cos(\frac{\pi}{2}n)$

For problems #10-#12: An LTI system has step response $2^n u[n]$.

10. Response to $3^n u[n]$:
(a) $3^n u[n] + 2^n u[n]$ **(b)** $(2)^n u[n] - u[n]$ **(c)** $2(3)^n u[n] - (2)^n u[n]$ **(d)** $(3)^n u[n] + 2u[n]$

11. Response to $\{1, -2\}$: **(a)** $\{1, -5\}$ **(b)** $\{1, -1\}$ **(c)** $-h[n]$ **(d)** $3(2)^n u[n]$ **(e)** $-(2)^n u[n]$

12. Response to $\cos(\pi n)$: **(a)** 0 **(b)** $\cos(\pi n - 1)$ **(c)** $\frac{2}{3}\cos(\pi n)$ **(d)** $\cos(\pi n)$ **(e)** $2\cos(\pi n)$

For problems #13-#15: An LTI system has impulse response $h[n] = 2^n u[n] + 3^n u[n]$.

13. Response to $(2.5)^n u[n]$: **(a)** $[(4.5)^n + (5.5)^n]u[n]$ **(b)** $[(2)^n - 5(3)^n + 6(2.5)^n]u[n]$
(c) $[(3)^n - (2)^n]u[n]$ **(d)** $[(2)^n + (3)^n + (2.5)^n]u[n]$ **(e)** $2[(3)^{n+1} - (2)^{n+1}]u[n]$

14. Response to $\{1, -5, 6\}$:
(a) $\{1, -5\}$ **(b)** $\{2, -5\}$ **(c)** $2h[n]$ **(d)** $2(3)^n u[n] + 3(2)^n u[n]$ **(e)** $4(3)^n u[n] - (2)^n u[n]$

15. The difference equation is: **(a)** $y[n] - 5y[n-1] + 6y[n-2] = 2x[n] - 5x[n-1]$
(b) $y[n] + 5y[n-1] + 6y[n-2] = x[n]$ **(c)** $y[n] + 5y[n-1] + 6y[n-2] = 5x[n-1]$
(d) $y[n] - 5y[n-1] + 6y[n-2] = x[n]$ **(e)** $y[n] + 2y[n-1] + 3y[n-2] = 5x[n-1]$

For problems #16-#18: The frequency response function is $H(\omega) = \frac{1-e^{-j2\omega}}{1+e^{-j2\omega}}$.

16. Response to $\cos(\frac{3\pi}{4}n)$: **(a)** 0 **(b)** $\cos(\frac{3\pi}{4}n)$ **(c)** $-\cos(\frac{3\pi}{4}n)$ **(d)** $\sin(\frac{3\pi}{4}n)$ **(e)** $-\sin(\frac{3\pi}{4}n)$

17. The response to $1 + 2\cos(\frac{\pi}{3}n) + 3\cos(\frac{2\pi}{3}n)$ is: **(a)** 1 **(b)** $-2\sqrt{3}\sin(\frac{\pi}{3}n) + 3\sqrt{3}\sin(\frac{2\pi}{3}n)$
(c) $2\sin(\frac{\pi}{3}n) - 3\sin(\frac{2\pi}{3}n)$ **(d)** $\frac{2}{\sqrt{3}}\cos(\frac{\pi}{3}n) + \frac{3}{\sqrt{3}}\cos(\frac{2\pi}{3}n)$ **(e)** $1 + 2\sin(\frac{\pi}{3}n) + 3\sin(\frac{2\pi}{3}n)$

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18. The response to $\cos(\omega n)$ blows up if $\omega =$: **(a)** 0 **(b)** $\frac{\pi}{4}$ **(c)** $\frac{\pi}{2}$ **(d)** π **(e)** never

For problems #19-#21: The difference equation is $y[n] = x[n] + ax[n-1] + x[n-2]$.

19. $y[n] = 0$ for $x[n] = \cos(\frac{\pi}{6}n)$ when $a =$: **(a)** 1 **(b)** $\sqrt{2}$ **(c)** $-\sqrt{2}$ **(d)** $\sqrt{3}$ **(e)** $-\sqrt{3}$

20. 60 Hz interference is eliminated in a system sampled at 144 Hertz when $a =$:
(a) 1 **(b)** $\sqrt{2}$ **(c)** $-\sqrt{2}$ **(d)** $\sqrt{3}$ **(e)** $-\sqrt{3}$

21. We can eliminate any 0-mean input with period=8 using 4 of these in series with $a =$:
(a) $\{0, 0, 0, 0\}$ **(b)** $\{1, -\sqrt{2}, 0, \sqrt{2}\}$ **(c)** $\{0, 2, 1, 2\}$ **(d)** $\{1, 1, 1, 1\}$ **(e)** $\{2, \sqrt{2}, 0, -\sqrt{2}\}$

For problems #22-#24: Difference eqn. is $y[n] - ay[n-1] = ax[n] - x[n-1], a > 1$.

22. The system is: **(a)** Stable **(b)** Has an unstable inverse **(c)** Unstable
(d) Has a stable inverse **(e)** Two of answers (a),(b),(c),(d) are true

23. Output $y[n]$ blows up unless $x[n] =$: **(a)** $\{1, -a\}$ **(b)** 1 **(c)** $a^n u[n]$ **(d)** $a^{-n}u[n]$

24. The gain $|H(\omega)| = 1$ for $\omega =$ (choose the best answer):
(a) 0 **(b)** 0 and π **(c)** π/a **(d)** all integer multiples of π/a **(e)** all values of ω

25. The filter eliminating discrete-time frequencies $\omega = \pi/4$ and $\omega = 3\pi/4$ is:
(a) $\{1, 0, 0, 0, 1\}$ **(b)** $\{1, 0, 1, 0, 1\}$ **(c)** $\{1, 0, 2, 0, 1\}$ **(d)** $\{1, .27, -1.46, .27, 1\}$

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. $[(z-0.7)(z^2+1)(z+1)]/[(z-0.8e^{j\pi/3})(z-0.8e^{-j\pi/3})(z-0.9e^{j3\pi/4})(z-0.9e^{-j3\pi/4})]$.

Sketch the relative magnitude of its frequency response (i.e., gain) on the plot below.

$-\pi$ 0 π

(10) 28. $x[n] \rightarrow \boxed{y[n] = x[n] + x[n-1] + x[n-2] + \ldots + x[n-5] + x[n-6] + x[n-7]} \rightarrow y[n]$

Here input $x[n]$ is a zero-mean, real-valued, and periodic signal having period=8.

Make a stem plot of $y[n]$ on the axis below. Don't worry about the vertical axis scale.

0 1 2 3 4 5 6 7 8 9

DID YOU REMEMBER TO SIGN THE HONOR PLEDGE?