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."

SIGN YOUR NAME HERE:

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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**
Do NOT write your answers on a separate sheet of paper or in a blue book.
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. $2e^{j\pi/3} - \sqrt{6}e^{j\pi/4} =$: **(a)** $1-\sqrt{3}$ **(b)** $j\sqrt{2}$ **(c)** $e^{j2\pi/3}$ **(d)** $\sqrt{2}e^{-j\pi/6}$ **(e)** 0

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2. $2e^{j\pi/6} + 2e^{j5\pi/6} - 2j =$: **(a)** $1-\sqrt{3}$ **(b)** $j\sqrt{2}$ **(c)** $e^{j2\pi/3}$ **(d)** $\sqrt{2}e^{-j\pi/6}$ **(e)** 0

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3. $Im[(1+j)e^{j\theta}] = 0$ for $\theta =$: **(a)** $\pi/4$ **(b)** $-\pi/4$ **(c)** $\pi/2$ **(d)** $-\pi/2$ **(e)** $-3\pi/4$

For #4-#7 let $x(t) = \begin{cases} t & \text{for } 0 < t < 2; \\ 0 & \text{for otherwise} \end{cases}$.

4. The **mean value** of $x(t)$ is:**(a)** 0 **(b)** 1/2 **(c)** 1 **(d)** 3/2 **(e)** 2

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5. The **mean square** value of $x(t)$ is: **(a)** 0 **(b)** 1/2 **(c)** 1 **(d)** 3/2 **(e)** 4/3

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6. The correlation $C(x, x^2)$ of $x(t)$ with $x(t)^2$ is:**(a)** 1 **(b)** 2 **(c)** 4 **(d)** 8 **(e)** 16

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7. The **support** of $y(t) = 3x(2t-1)$ is:
(a) $\frac{1}{2} < t < \frac{3}{2}$ **(b)** $0 < t < 1$ **(c)** $0 < t < 2$ **(d)** $1 < t < 2$ **(e)** $-\frac{1}{2} < t < \frac{1}{2}$

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8. The **period** of $5\cos(\frac{2\pi}{6}t) + 7\cos(\frac{2\pi}{9}t)$ is: **(a)** 1/3 **(b)** 3 **(c)** 6 **(d)** 18 **(e)** 54

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9. The **period** of $x[n] = 3\cos(2\pi 0.075n + 1)$ for **integer** n is:
(a) 1 **(b)** 1/0.075 **(c)** 40 **(d)** 75 **(e)** not periodic

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10. $2\cos(7t+\pi/3) - \sqrt{6}\cos(7t+\pi/4) + \sqrt{3}\cos(7t) =$:
(a) $2\cos(7t+\pi/3)$ **(b)** $2\sqrt{3}\cos(7t)$ **(c)** $\cos(7t)$ **(d)** $\sin(7t)$ **(e)** 0

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11. $2\cos(7t+\pi/6) + 2\cos(7t+5\pi/6) + 3\sin(7t) =$:
(a) $2\cos(7t+\pi/3)$ **(b)** $2\sqrt{3}\cos(7t)$ **(c)** $\cos(7t)$ **(d)** $\sin(7t)$ **(e)** 0

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12. The **line spectrum** of $x(t) = \cos^2(7t)$ has components at $\omega =$:
(a) $7, -7$ **(b)** $-7, 0, 7$ **(c)** $-14, -7, 0, 7, 14$ **(d)** $-14, 0, 14$ **(e)** $-14, -7, 7, 14$

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For #13-#15 let $x(t) = 4e^{-j2t} + 3e^{-jt} + 5 + 3e^{jt} + 4e^{j2t}$.

13. The frequency of the **first harmonic** in $\frac{\text{RADIAN}}{\text{SECOND}}$ is: **(a)** 0 **(b)** 1 **(c)** 2 **(d)** 3 **(e)** 4

14. The **average power** of $x(t)$ is: **(a)** 12 **(b)** 19 **(c)** 25 **(d)** 50 **(e)** 75

15. If $x(t)$ is passed through a **low-pass filter** that passes frequencies below **1 Hz** and rejects frequencies above **1 Hz**, the result is:
(a) 5 **(b)** $5+\frac{3}{2}\cos(t)$ **(c)** $5+6\cos(t)$ **(d)** $5+\frac{3}{2}\cos(t)+2\cos(2t)$ **(e)** $5+6\cos(t)+8\cos(2t)$

16. Let $x_k[n] = \cos(\frac{2\pi k}{25}n)$ and $y_k[n] = \sin(\frac{2\pi k}{25}n)$ for integers n. Then:
(a) $C(x_5, y_9) < C(x_5, x_9)$ **(b)** $C(x_5, y_9) > 1$ **(c)** $C(x_5, y_9) = C(x_5, y_6)$
(d) $Im[C(x_5, y_9)] \neq 0$ **(e)** $C(x_5, y_9) < 0$ (where $C(x, y) = \sum_{n=0}^{24} x[n]y[n]$).

For #17 and #18 let $X[k] = \frac{1}{N}\sum_{n=0}^{N-1} x[n]e^{-j2\pi nk/N}$ where N=period of $x[n]$.

17. Let $x[n]$ be periodic with period 11 and $x[n] = -n$ for $-5 \leq n \leq 5$. Then:
(a) $X[0] = 0$ **(b)** $X[0] \neq 0$ **(c)** $Im[X[0]] \neq 0$ **(d)** $X[0] = \frac{1}{11}$ **(e)** $Re[X[0]] \neq 0$

18. Let $x[n]$ be periodic with period 20 and $x[n] = \begin{cases} 1 & \text{for } 0 \leq n \leq 9 \\ -1 & \text{for } 10 \leq n \leq 19 \end{cases}$. Then:
(a) $X_0 = X_2 = \ldots = X_{18} = 0$ **(b)** $X_1 = X_3 = \ldots = X_{19} = 0$ **(c)** $X_{10} = \ldots = X_{19} = 0$
(d) $x[n]$ has period 10 as well as 20 **(e)** $x[n]$ has zero power

19. Let $x[n] = e^{j2\pi nk/N}$. Then the line spectrum of its complex conjugate $x^*[n]$:
(a) Is the same as that of $x[n]$ **(b)** does not exist since its phase is zero
(c) Is the same as that of $\cos(\frac{2\pi kn}{N})$ **(d)** does not exist since it isn't real
(e) Is the same as that of $e^{j2\pi(N-k)n/N}$.

20. $x[n] = \cos(2\pi 0.02n)\sin(2\pi 0.3n)$ has:
(a) Two spectral line components **(b)** A spectral line component at $2\pi 0.32$ **(c)** A non-periodic envelope **(d)** Period 100 **(e)** Same line spectrum as $\cos(2\pi 0.02n)\sin(-2\pi 0.3n)$

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(10) 21. Sketch **carefully** the line spectrum of $x[n] = 5 + 2\cos(6\pi n) + 6\cos(10\pi n)$.
Label carefully with numerical values the heights of all spectral lines.

-10	-8	-6	-4	-2	0	2	4	6	8	10	f (Hertz)

(10) 22. Let $x(t) = e^{j2\pi kt/T}$ and $y(t) = e^{j2\pi\alpha t/T}$ and $C(x,y) = \int_0^T x(t)y^*(t)dt$.
Show that if k is an integer and α is NOT an integer, then $C(x,y) \neq 0$.

DID YOU REMEMBER TO SIGN THE HONOR PLEDGE?