**Instructions:**

- Answer on this questionnaire
- Print your name
- Sign the pledge below
- Closed book and notes
- One 8 1/2 x 11 sheet of paper allowed
- Calculators allowed
- Read the questions carefully.
- Problems 1 to 10 are multiple-choice. Each has 7 points. No partial credit will be given.
- In Problems 11 and 12, partial credit will be given. You must show your derivations/calculations to get full credit.

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Name:

PLEDGE: I have neither given nor received any aid on this exam, nor have I concealed any violations of the Honor Code.

SIGNATURE:

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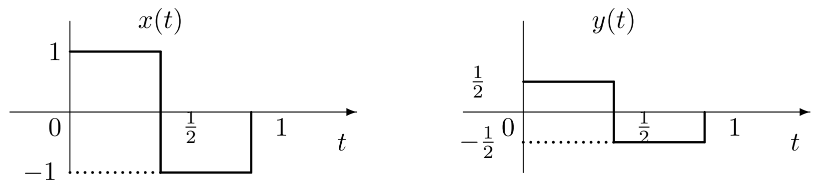
DO NOT TURN THIS PAGE OVER UNTIL TOLD TO DO SO!
Good Luck!

Mark your answers for Problems (1)–(10)

| | |
|---|---|
| (1) | (a) (b) (c) (d) (e) |
| (2) | (a) (b) (c) (d) (e) |
| (3) | (a) (b) (c) (d) (e) |
| (4) | (a) (b) (c) (d) (e) |
| (5) | (a) (b) (c) (d) (e) |
| (6) | (a) (b) (c) (d) (e) |
| (7) | (a) (b) (c) (d) (e) |
| (8) | (a) (b) (c) (d) (e) |
| (9) | (a) (b) (c) (d) (e) |
| (10) | (a) (b) (c) (d) (e) |
| Subtotal | |
| (11) | |
| (12) | |
| Total | |

(1) The normalized correlation $C_N(x, y)$ of the following two signals with the support interval $[0, 1]$ is

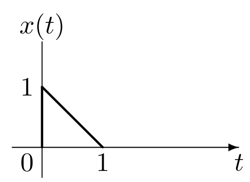
(a) $-1$
(b) $-\frac{1}{\sqrt{2}}$
(c) $\frac{1}{\sqrt{2}}$
(d) $1$
(e) None of the above



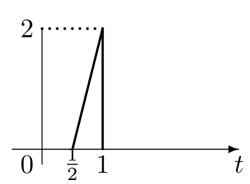

(2) The average power of $x(t) = Ae^{j(\omega_0 t + \phi)}$ over the interval $[0, T_0]$, where $A > 0$ and $\omega_0 = \frac{2\pi}{T_0}$, is

(a) $A^2 \cos^2 \phi$
(b) $A^2$
(c) $A^2 T_0$
(d) $A^2 |\cos \phi|$
(e) None of the above

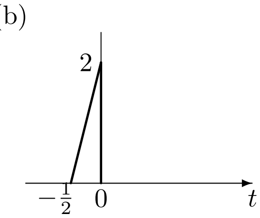
(3) For signal $x(t)$ given below, the signal $y(t) = 2x\big(-\frac{1}{2}t + 1\big)$ looks like



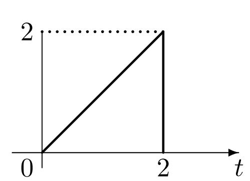

(a)



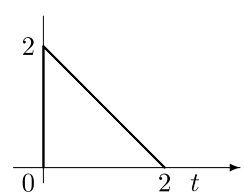

(b)




(c)

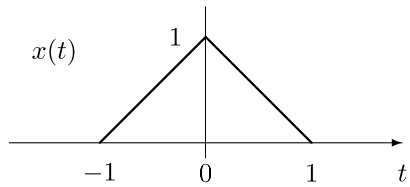



(d)

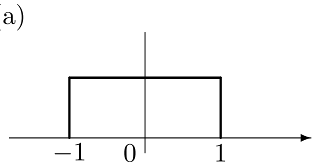



(e) None of the above

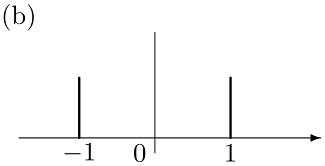
(4) The distribution of signal values of $x(t)$ over the support interval $[-1, 1]$ looks like



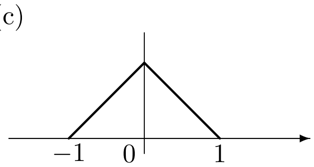

(a)



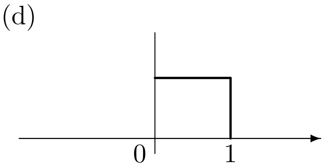

(b)




(c)

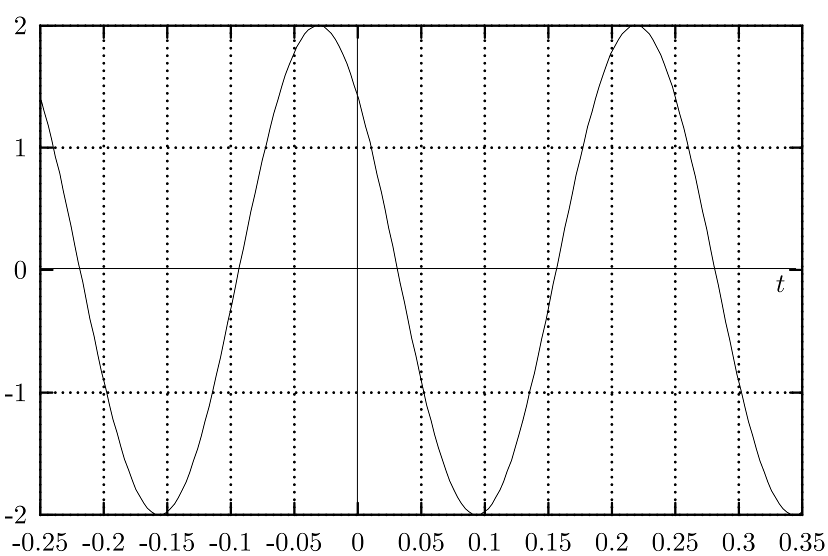



(d)




(e) None of the above

(5) The following graph of a signal is best described by




(a) $2\cos(2\pi 2t - \frac{\pi}{4})$
(b) $2\cos(2\pi 4t - \frac{\pi}{4})$
(c) $2\cos(2\pi 2t + \frac{\pi}{4})$
(d) $2\cos(2\pi 4t + \frac{\pi}{4})$
(e) $2\cos(2\pi 4t + \frac{\pi}{10})$

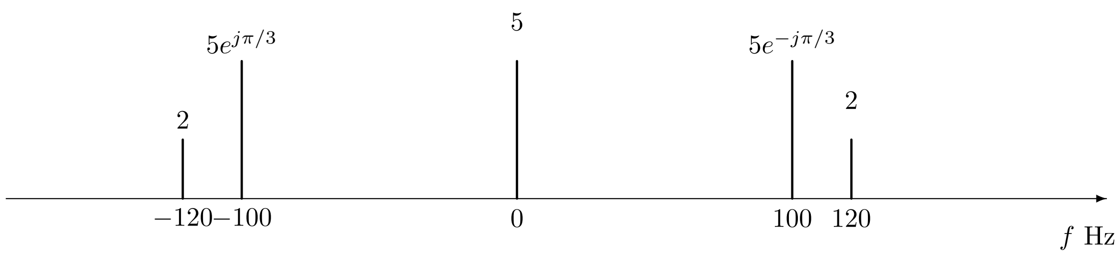
(6) The signal

$$\Re\{3e^{j(6t+\frac{\pi}{3})} + j4e^{j(6t+\frac{\pi}{2})}\}$$

equals

(a) $2\sqrt{2}\cos(6t - \frac{\pi}{4})$
(b) $2\sqrt{2}\cos(6t + \frac{\pi}{4})$
(c) $2\sqrt{2}\cos(6t - \frac{3\pi}{4})$
(d) $2\sqrt{2}\cos(6t + \frac{3\pi}{4})$
(e) None of the above

(7) The spectrum below describes signal




(a) $5 + 5\cos(2\pi 100t - \frac{\pi}{3}) + 2\cos(2\pi 120t)$
(b) $5 + 10\cos(2\pi 100t - \frac{\pi}{3}) + 4\cos(2\pi 120t)$
(c) $5 + 5\sin(2\pi 100t - \frac{\pi}{3}) + 2\sin(2\pi 120t)$
(d) $5 + 10\sin(2\pi 100t - \frac{\pi}{3}) + 4\sin(2\pi 120t)$
(e) None of the above

(8) A real signal $x(t)$ with the following spectrum

$$C_0 = 10, \quad C_1 = 5e^{j\pi/2}, \quad C_2 = 1e^{j\pi},$$

and $C_k = 0$ for $k \geq 3$, has the average power of

(a) 16
(b) 100
(c) 126
(d) 152
(e) None of the above

(9) Given a periodic signal $x(t)$ with the fundamental period $T_0$ and $y(t) = e^{j2\pi \frac{k}{T_0} t}$, the unnormalized correlation $C(x, y)$ over the interval $[-\frac{T_0}{2}, \frac{T_0}{2}]$ is given by

(a) $C_k T_0$
(b) $C_k T_0/2$
(c) $|C_k| T_0$
(d) $|C_k| T_0/2$
(e) Insufficient information given

where $C_k$ is the Fourier coefficient of signal $x(t)$ at frequency $\frac{k}{T_0}$ Hz.

(10) For a real signal with the Fourier coefficient $C_{-4} = 5e^{j\frac{\pi}{2}}$, the value of $C_4$ is

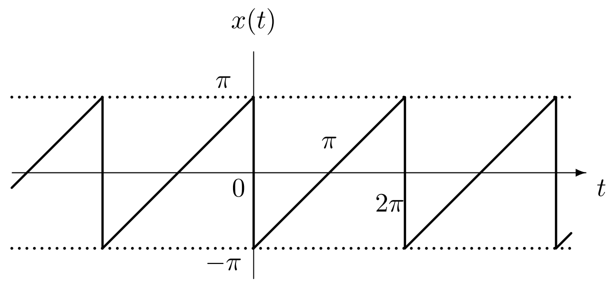
(a) $5e^{j\frac{\pi}{2}}$
(b) $-5e^{j\frac{\pi}{2}}$
(c) $5e^{-j\frac{\pi}{2}}$
(d) $-5e^{-j\frac{\pi}{2}}$
(e) Insufficient information given

(11) (15 points) Simplify the following signal in the standard sinusoidal form.

$$x(t) = -4\cos(\omega_0 t) + 5\sin(\omega_0 t - \frac{\pi}{3}).$$

(12) (20 points) Find and plot the (two-sided) spectrum of the following periodic signal

$$x(t) = t - \pi, \quad 0 \le t \le 2\pi.$$




Note that $\int (at+b)e^{ct}\,dt = (at+b)e^{ct}/c - ae^{ct}/c^2 + K.$