

## ECE 2026

## QUIZ 1

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING  
GEORGIA INSTITUTE OF TECHNOLOGY

SEPTEMBER 21, 2026

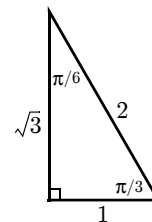
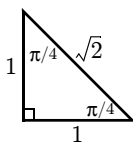
Name: \_\_\_\_\_ FIRST \_\_\_\_\_ LAST \_\_\_\_\_ GTID \_\_\_\_\_

1. The quiz is closed book, closed notes, except for one double-sided *handwritten* sheets of notes. (Pen on paper, nothing from a tablet, nothing printed.)
2. No electronics (no watches/calculators/readers/phones/etc.)
3. Final answers must be entered into the answer box.
4. Correct answers *must be accompanied by concise justifications* to receive full credit.
5. Only the *front* side of each page will be scanned and graded, do not attach additional sheets.
6. Express all angles as a fraction of  $\pi$ . For example, write  $0.1\pi$  instead of  $18^\circ$  or 0.3142 radians.

| Problem | Points | Score |
|---------|--------|-------|
| 1       | 36     |       |
| 2       | 28     |       |
| 3       | 36     |       |
| TOTAL:  | 100    |       |

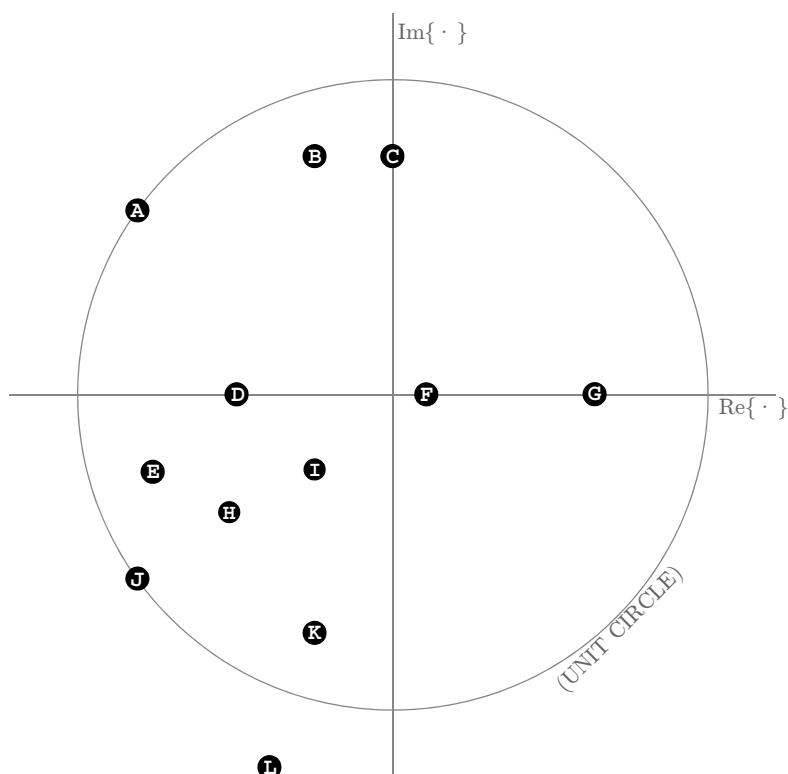
Since you do not have a calculator, this table may or may not be useful:

| $\theta$       | $0^\circ$ | $30^\circ$           | $45^\circ$           | $60^\circ$           | $90^\circ$      |
|----------------|-----------|----------------------|----------------------|----------------------|-----------------|
|                | 0         | $\frac{\pi}{6}$      | $\frac{\pi}{4}$      | $\frac{\pi}{3}$      | $\frac{\pi}{2}$ |
| $\sin(\theta)$ | 0         | $\frac{1}{2}$        | $\frac{\sqrt{2}}{2}$ | $\frac{\sqrt{3}}{2}$ | 1               |
| $\cos(\theta)$ | 1         | $\frac{\sqrt{3}}{2}$ | $\frac{\sqrt{2}}{2}$ | $\frac{1}{2}$        | 0               |



**PROB. Fa26-Q1.1.** Shown below are the locations of twelve numbers in the complex plane, labeled A through L. Let  $z^*$  denote the complex conjugate of  $z$ . Match each function of  $z = 0.8e^{j0.6\pi}$  listed below to its location in the complex plane by writing a letter (from A to L) into each answer box:

- (1)   $z = 0.8e^{j0.6\pi}$
- (2)   $1/z$
- (3)   $z^*$
- (4)   $z - j$
- (5)   $(z - z^*)/2$
- (6)   $z + z^*$
- (7)   $jz$
- (8)   $z^2$
- (9)   $z/z^*$
- (10)   $z^{10}$
- (11)   $zz^*$
- (12)   $z^*/z$

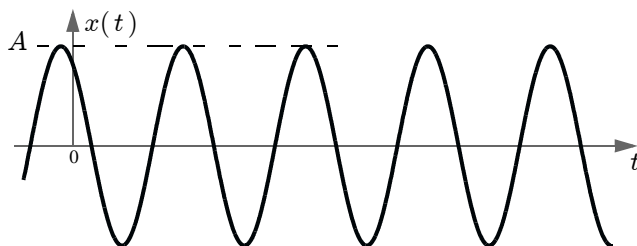


**PROB. Fa26-Q1.2.** Let  $x(t) = 2\cos(25\pi(t - t_d)) - \sqrt{2}\sin(25\pi t)$ , where the delay  $t_d$  is unspecified.

- (a) Let  $X$  denote the *phasor* (complex amplitude) of  $x(t)$ . Write the *phasor equation* (from the phasor addition rule) that relates  $X$  to the phasors of the other two sinusoids in the above equation:

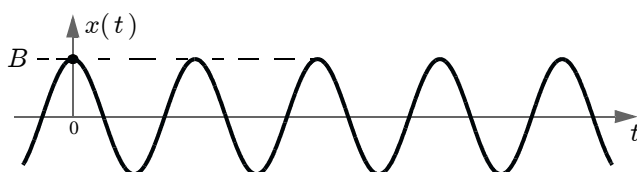
a function of  $t_d$  but not  $t$

- (b) Shown below is a plot of  $x(t)$  for the special case when  $t_d = 0$ ; as indicated in the plot, the amplitude is:



$$A = \boxed{\phantom{000000}}.$$

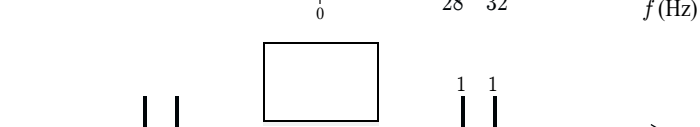
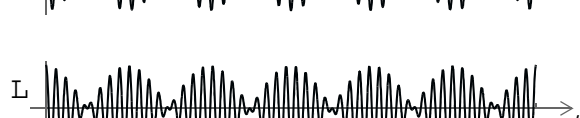
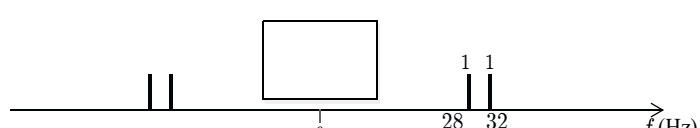
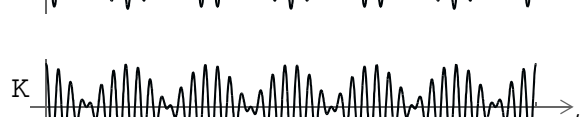
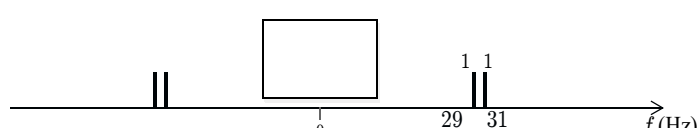
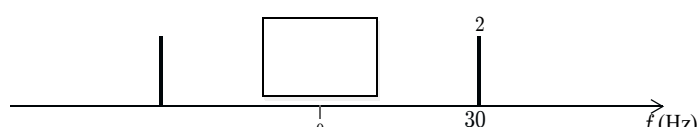
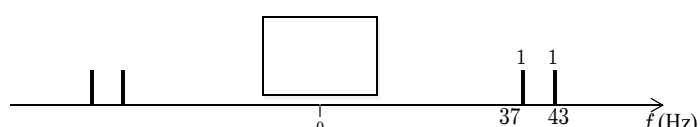
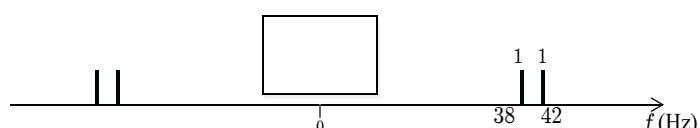
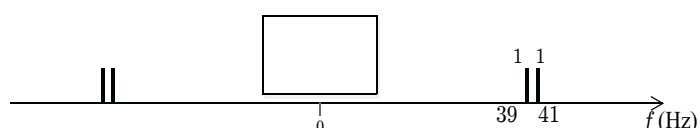
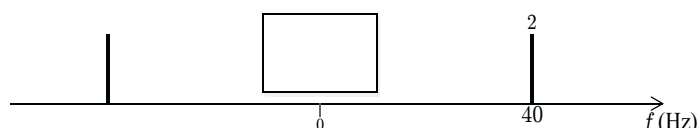
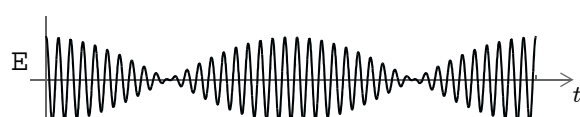
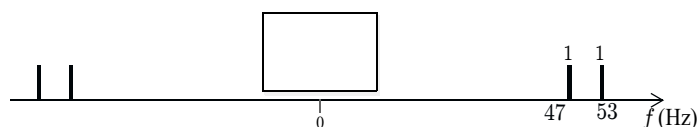
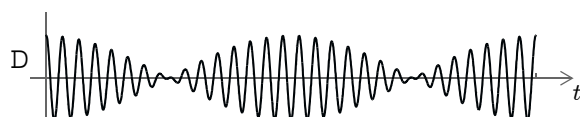
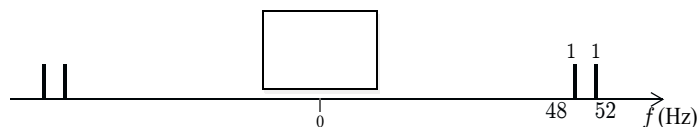
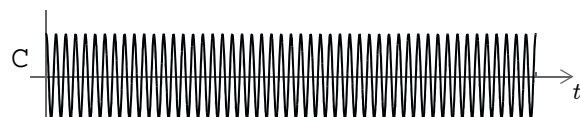
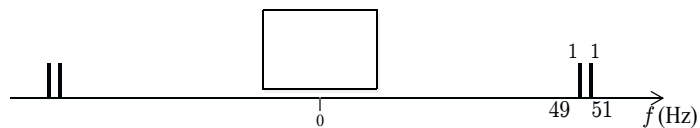
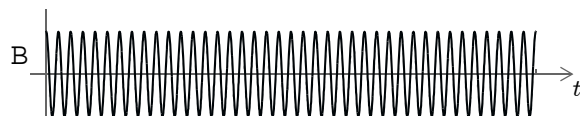
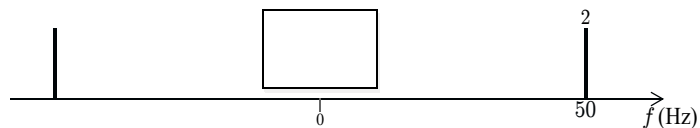
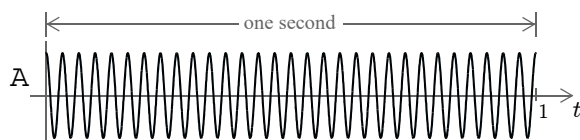
- (c) Find the *smallest* positive value of  $t_d$  so that  $x(t)$  achieves a peak at time zero, as shown below, and further identify the value  $B$  of that peak:



$$t_d = \boxed{\phantom{000000}},$$

$$B = \boxed{\phantom{000000}}.$$

**PROB. Fa26-Q1.3.** Shown on the left are twelve signals labeled A through L, for time ranging from  $0 < t < 1$ . The amplitude scale is the same for all plots. Shown on the right are the corresponding spectra, but in a scrambled order. Match each spectrum to its time-domain plot by writing a letter (from A to L) into each answer box.



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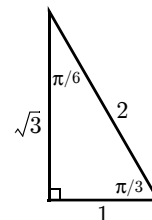
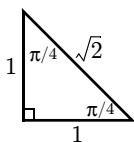
Name: **SOLUTIONS** **VERSION A** \_\_\_\_\_  
FIRST LAST GTID

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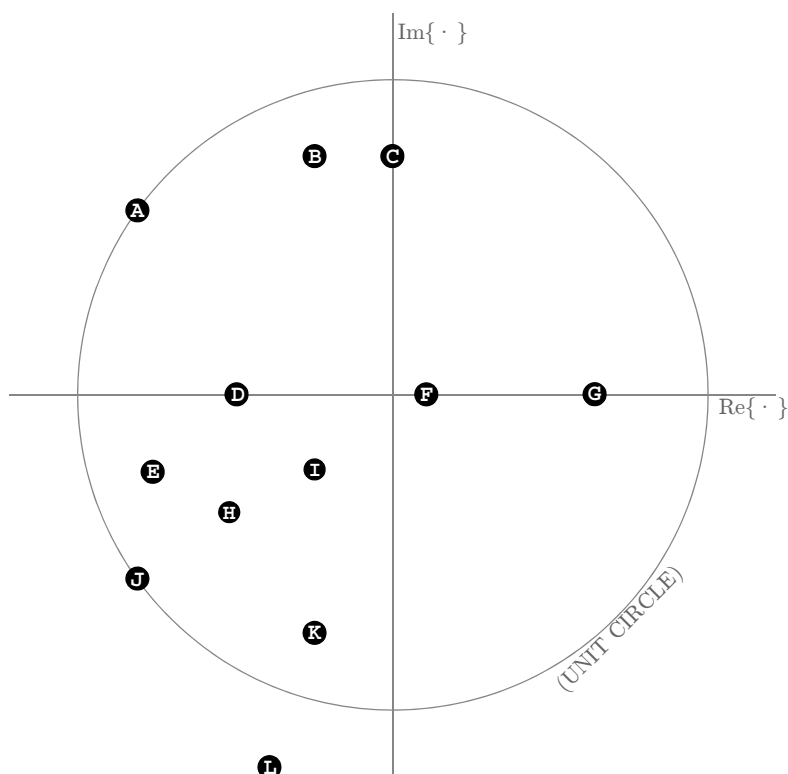
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- (2) L  $1/z$
- (3) K  $z^*$
- (4) I  $z - j$
- (5) C  $(z - z^*)/2$
- (6) D  $z + z^*$
- (7) E  $jz$
- (8) H  $z^2$
- (9) J  $z/z^*$
- (10) F  $z^{10}$
- (11) G  $zz^*$
- (12) A  $z^*/z$



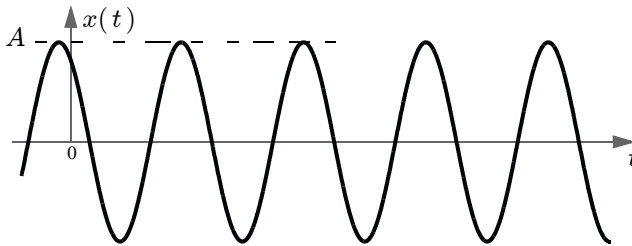
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$$X = 2e^{-j25\pi t_d} + j\sqrt{2}$$

a function of  $t_d$  but not  $t$

- (b) Shown below is a plot of  $x(t)$  for the special case when  $t_d = 0$ ; as indicated in the plot, the amplitude is:

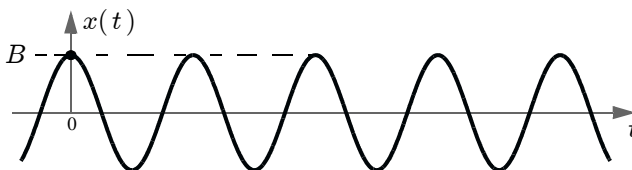


$$A = \sqrt{6} > 0$$

$$t_d = 0 \Rightarrow X = 2 + j\sqrt{2}$$

$$\Rightarrow A = |X| = \sqrt{6}$$

- (c) Find the *smallest* positive value of  $t_d$  so that  $x(t)$  achieves a peak at time zero, as shown below, and further identify the value  $B$  of that peak:



$$t_d = 0.01 > 0$$

$$B = \sqrt{2} > 0$$

peak at 0  $\Rightarrow X = B$  is *real* and positive

$$B = 2e^{-j25\pi t_d} + j\sqrt{2}$$

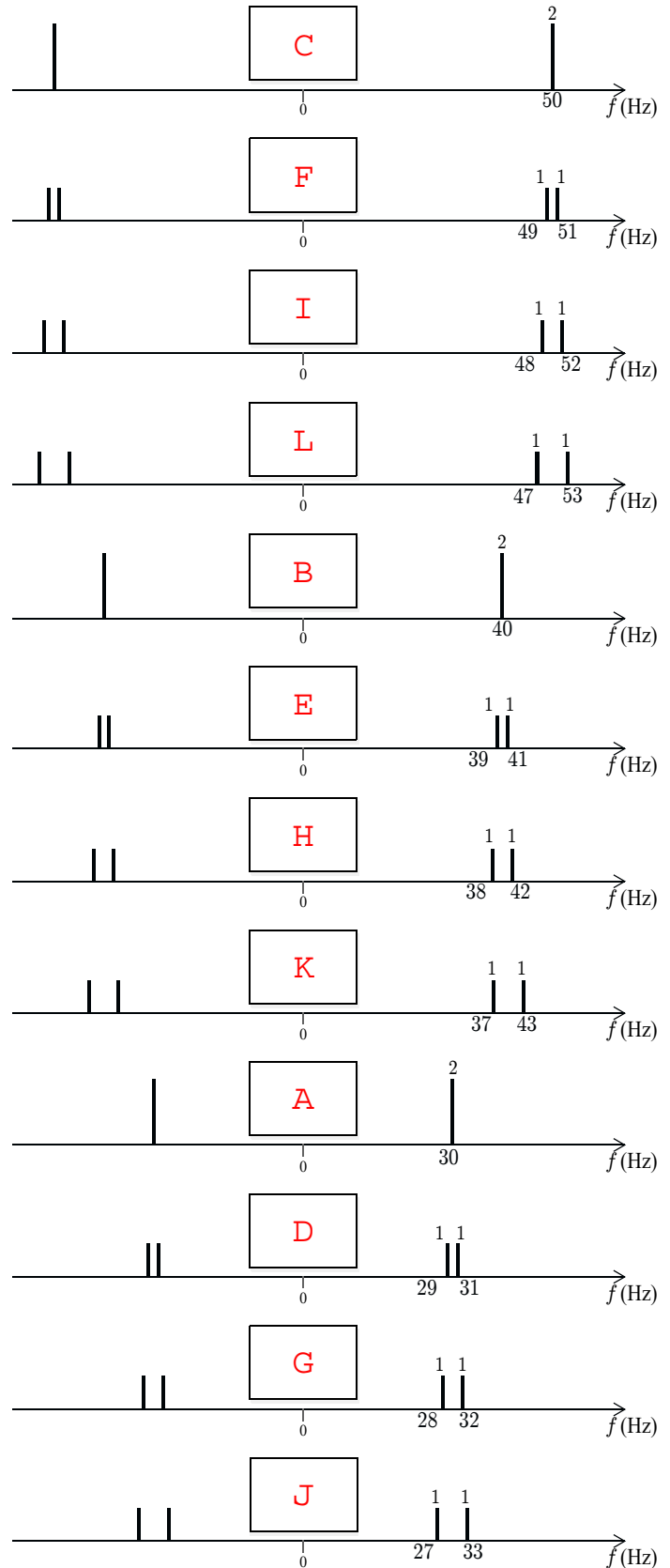
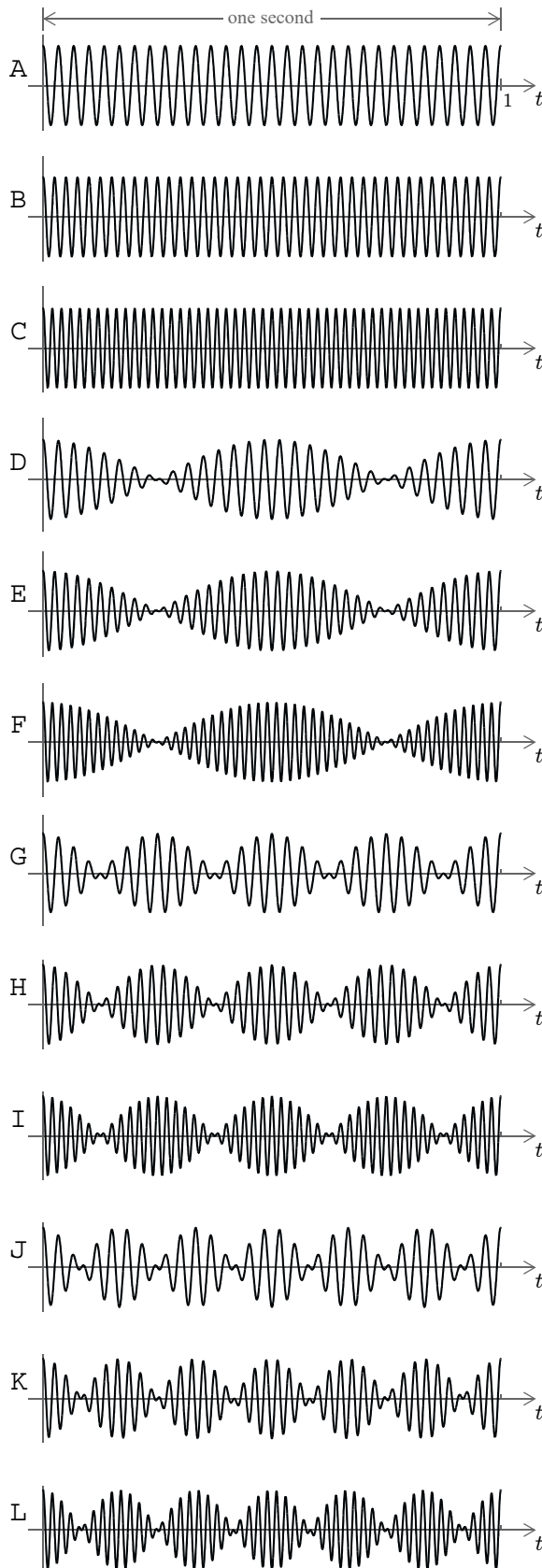
$$\text{Equate imaginary parts} \Rightarrow 2\sin(25\pi t_d) = \sqrt{2} \Rightarrow t_d = 0.01$$

$$\text{Equate real parts} \Rightarrow B = 2\cos(0.25\pi) = \sqrt{2}$$

Approach 1 — count beats and equate  $f_b = f_2 - f_1$ , with center  $f_c = (f_1 + f_2)/2$

Approach 2 — view as AM  $m(t)\cos(2\pi f_c t)$  with  $m(t)$  a sinusoid with frequency  $\in \{0, 1, 2, 3\}$

**PROB. Fa26-Q1.3.** Shown on the left are twelve signals labeled A through L, for time ranging from  $0 < t < 1$ . The amplitude scale is the same for all plots. Shown on the right are the corresponding spectra, but in a scrambled order. Match each spectrum to its time-domain plot by writing a letter (from A to L) into each answer box.



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