GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 2026 Spring 2022
Quiz #1

February 11, 2022

NAME: _____ _____ GT username: _____
(FIRST) (LAST) (e.g., gtxyz123)

To earn 2 points, circle your recitation section:

L01 (Tai)	L07 (Tai)	L09 (Hessler)	L11 (Hessler)
L02 (Duan)	L08 (Sadiq)	L10 (Sadiq)	L12 (Duan)

Important Notes:

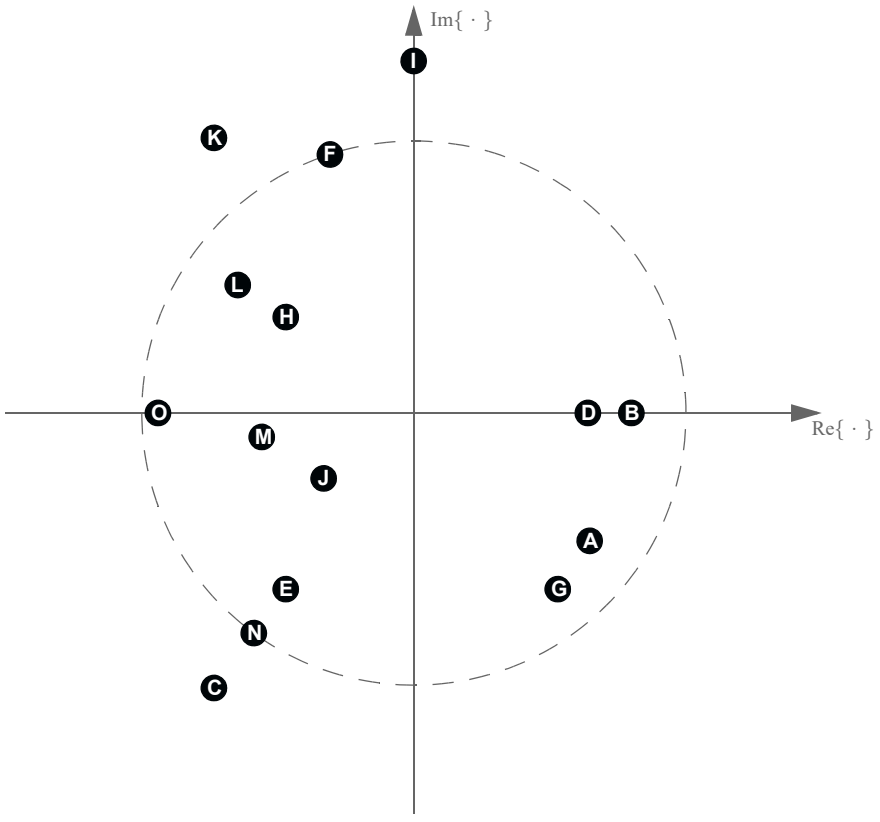
- *Do not unstaple the test.*
- One two-sided page (8.5" $\times$ 11") of hand-written notes permitted.
- Calculators are allowed, but no smartphones/tablets/readers/etc.
- JUSTIFY your reasoning CLEARLY to receive partial credit.
- Express all angles as a fraction of π. For example, write 0.1π as opposed to 18° or 0.3142 radians.
- You must write your answer in the space provided on the exam paper itself.
  Only these answers will be graded. Write your answers in the provided answer boxes.
  If more space is needed for scratch work, use the backs of the previous pages.

Problem	Value	Score
1	30	
2	33	
3	35	
RECITATION	2	
Total		

PROB. Sp22-Q1.1. Let $z = 0.8e^{-j0.7\pi}$. Here is a list of fifteen numbers that are all dependent on z:

z	z^4	$\frac{1}{z}$	$\frac{1}{z^*}$	$\lvert z \rvert$
$\frac{z}{\lvert z \rvert}$	$\frac{z}{z^*}$	zz^*	$z + z^*$	$z^* - z$
$z + 1$	$z + j$	jz	$\frac{z}{j}$	$\frac{z}{1+j}$

Shown below are the locations of these fifteen numbers in the complex plane. Match each number above to its corresponding location in the complex plane below; indicate your answer by writing a letter from {A, B, C, ... O} in each answer box above. (Use each letter once.)



PROB. Sp22-Q1.2.

Let $x(t) = \cos(2\pi f_0 t)$ be a sinusoid whose period is $\frac{1}{f_0} = 1.2$ seconds.

Define a new signal as the sum of two different delayed versions of this sinusoid, according to:

$$y(t) = x(t - \tau) + x(t - 2\tau),$$

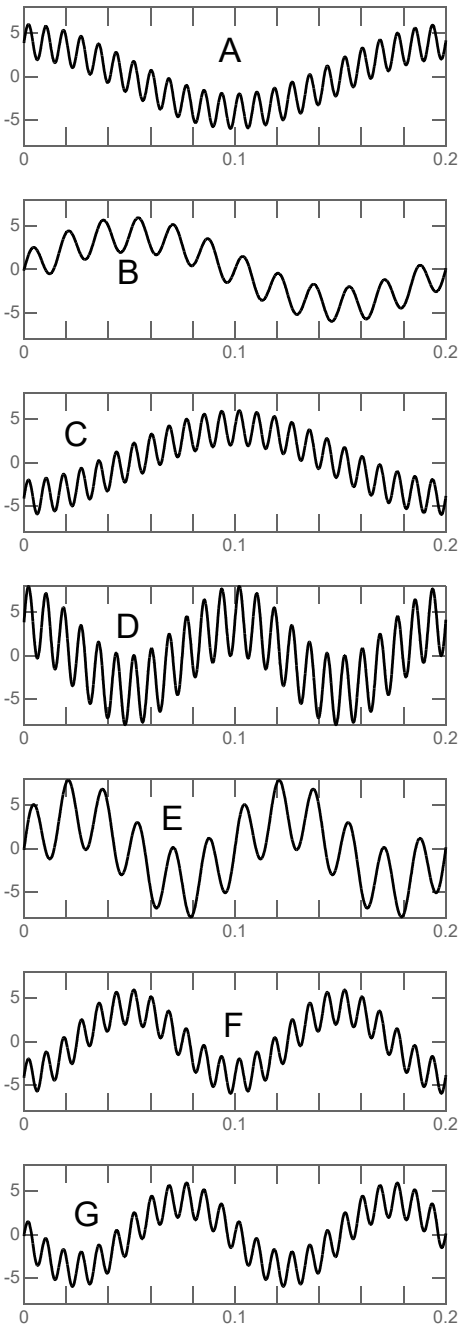
where the delay parameter τ is unspecified. (The first is delayed by τ, the second by 2τ.)

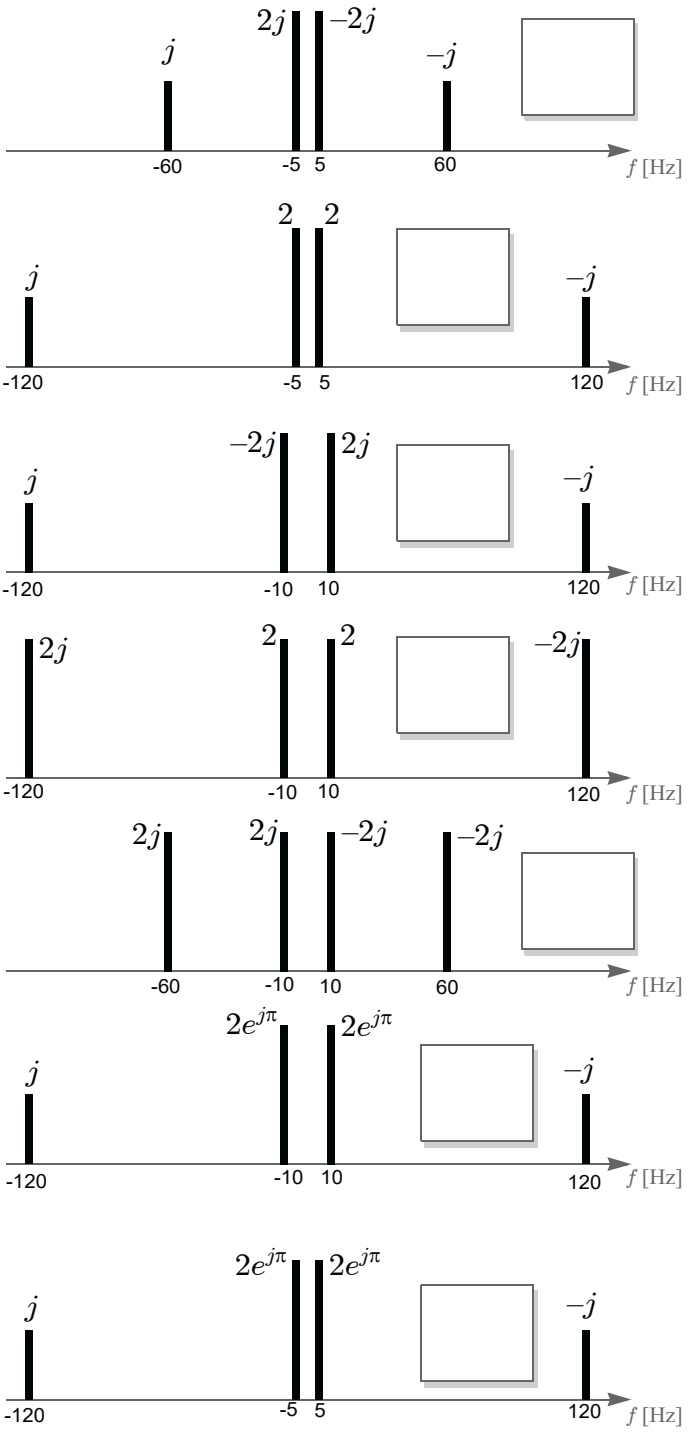
(a) The smallest positive value of τ for which the sum is $y(t) = 0$ (for all t) is $\tau =$ [ ] secs.

(b) The smallest positive (nonzero!) value of τ for which the sum is $y(t) = 2\cos(2\pi f_0 t)$ is $\tau =$ [ ] secs.

(c) The smallest positive value of τ for which the sum is $y(t) = \sqrt{3}\sin(2\pi f_0 t)$ (not cos) is $\tau =$ [ ] secs.

PROB. Sp22-Q1.3. Match each signal plotted on the left (labeled A through G) to its corresponding spectrum on the right; indicate your answer by writing a letter (from A through G) into each answer box:





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ECE 2026 Spring 2022
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February 11, 2022

NAME: **ANSWER KEY** (FIRST) (LAST) GT username: **A** (e.g., gtxyz123)

To earn 2 points, circle your recitation section:

L01 (Tai)	L07 (Tai)	L09 (Hessler)	L11 (Hessler)
L02 (Duan)	L08 (Sadiq)	L10 (Sadiq)	L12 (Duan)

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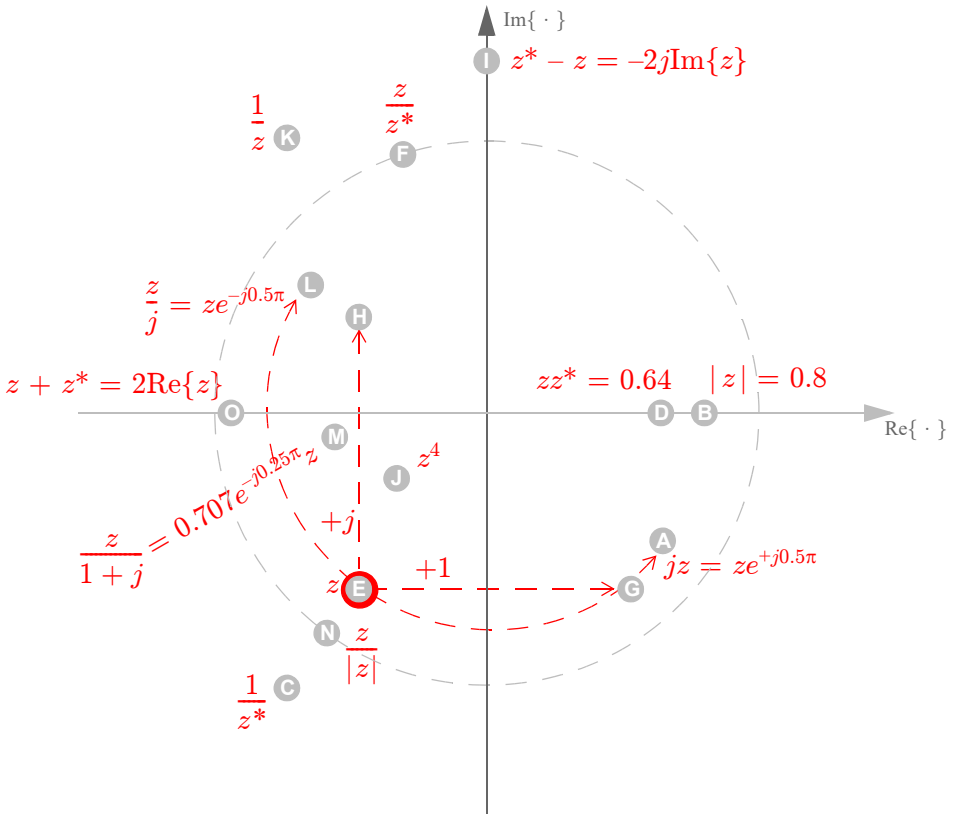
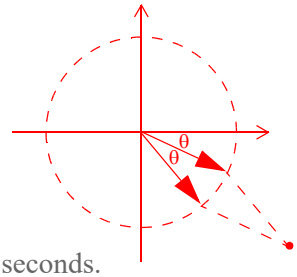
Problem	Value	Score
1	30	
2	33	
3	35	
RECITATION	2	
Total		

PROB. Sp22-Q1.1. Let $z = 0.8e^{-j0.7\pi}$. Here is a list of fifteen numbers that are all dependent on z:

E z	**J** z^4	**K** $\frac{1}{z}$	**C** $\frac{1}{z^*}$	**B** $\lvert z \rvert$
N $\frac{z}{\lvert z \rvert}$	**F** $\frac{z}{z^*}$	**D** zz^*	**O** $z + z^*$	**I** $z^* - z$
G $z + 1$	**H** $z + j$	**A** jz	**L** $\frac{z}{j}$	**M** $\frac{z}{1+j}$

Shown below are the locations of these fifteen numbers in the complex plane. Match each number above to its corresponding location in the complex plane below; indicate your answer by writing a letter from {A, B, C, ... O} in each answer box above. (Use each letter once.)





corresponding phasor equation:

$Ae^{j\varphi} = e^{-j\theta} + e^{-j2\theta}$

where $\theta = 2\pi f_0 \tau$

PROB. Sp22-Q1.2.

Let $x(t) = \cos(2\pi f_0 t)$ be a sinusoid whose period is $\frac{1}{f_0} = 1.2$ seconds.

Define a new signal as the sum of two different delayed versions of this sinusoid, according to:

$$y(t) = x(t - \tau) + x(t - 2\tau),$$

where the delay parameter τ is unspecified. (The first is delayed by τ, the second by 2τ.)

(a) The smallest positive value of τ for which the sum is $y(t) = 0$ (for all t) is $\tau =$ **0.6** secs.

Start with above picture, increase θ until the two phasors cancel eachother

$\Rightarrow$ until $e^{-j\theta}$ points left ($\theta = \pi$), so that $e^{-j2\theta}$ points right

$\Rightarrow \theta = \pi = 2\pi f_0 \tau$

$\Rightarrow \tau = \frac{1}{2f_0} = 0.6$

(b) The smallest positive (nonzero!) value of τ for which the sum is $y(t) = 2\cos(2\pi f_0 t)$ is $\tau =$ **1.2** secs.

Start with above picture, increase θ until the two phasors point in the same direction

$\Rightarrow$ until $e^{-j\theta}$ points right ($\theta = 2\pi$) and $e^{-j2\theta}$ also points right

$\Rightarrow \theta = 2\pi = 2\pi f_0 \tau$

$\Rightarrow \tau = \frac{1}{f_0} = 1.2$

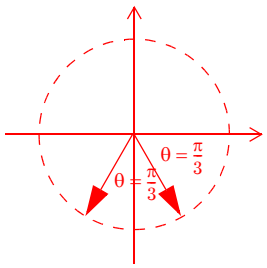
(c) The smallest positive value of τ for which the sum is $y(t) = \sqrt{3}\sin(2\pi f_0 t)$ (not cos) is $\tau =$ **0.2** secs.

The complex phasor for $\sqrt{3}\sin(2\pi f_0 t)$ is $Ae^{j\varphi} = -j\sqrt{3}$, which points *straight down*

$\Rightarrow$ Start with above picture, increase θ until the sum of the two phasors points *down:*

$\Rightarrow \theta = \frac{\pi}{3} = 2\pi f_0 \tau$

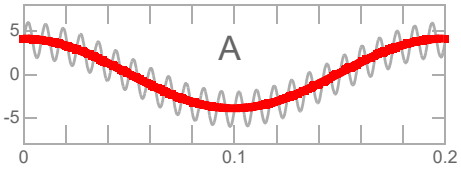
$\Rightarrow \tau = \frac{1}{6f_0} = 0.2$



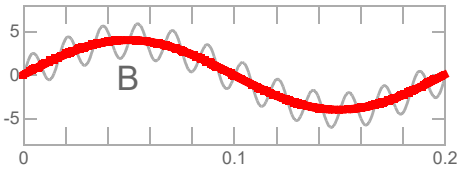
PROB. Sp22-Q1.3. Match each signal plotted on the left (labeled A through G) to its corresponding spectrum on the right; indicate your answer by writing a letter (from A through G) into each answer box:

Low-frequency component:

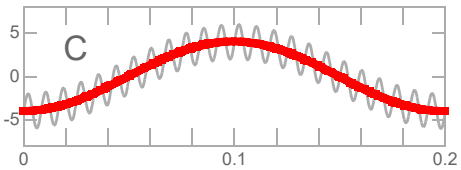
5 Hz cos



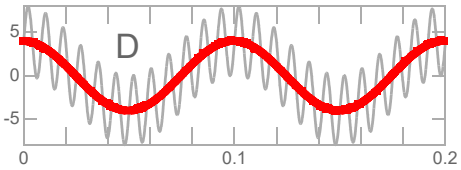
5 Hz sin



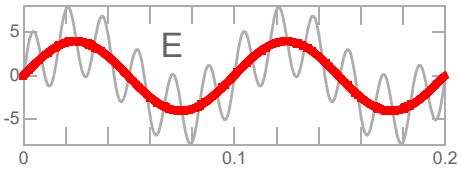
5 Hz –cos



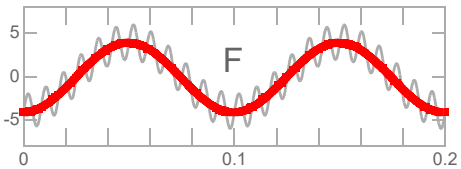
10 Hz cos



10 Hz sin



10 Hz –cos



10 Hz –sin