GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 2026 — Fall 2012
Quiz #1

September 17, 2012

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

Circle your recitation section in the chart below (otherwise you lose 3 points!):

	Mon	Tue	Wed	Thu
9:30 – 11am				L06 (Fekri)
12 – 11:30pm		L07 (Al-Regib)		L08 (Fekri)
1:30 – 3pm		L09 (Al-Regib)		L10 (Rozell)
3 – 4:30pm	L01 (Juang)	L11 (Davenport)	L02 (Zajic)	L12 (Rozell)
4:30 – 6pm	L03 (Baxley)	L13 (Davenport)	L04 (Zajic)	
6 – 7:30pm	L05 (Baxley)			

Important Notes:

- DO NOT unstaple the test.
- One two-sided page (8.5” × 11”) of hand-written notes permitted.
- JUSTIFY your reasoning CLEARLY to receive partial credit.
- You must write your answer in the space provided on the exam paper itself.
  Only these answers will be graded. Circle your answers, or write them in the boxes provided.
  If more space is needed for scratch work, use the backs of the previous pages.

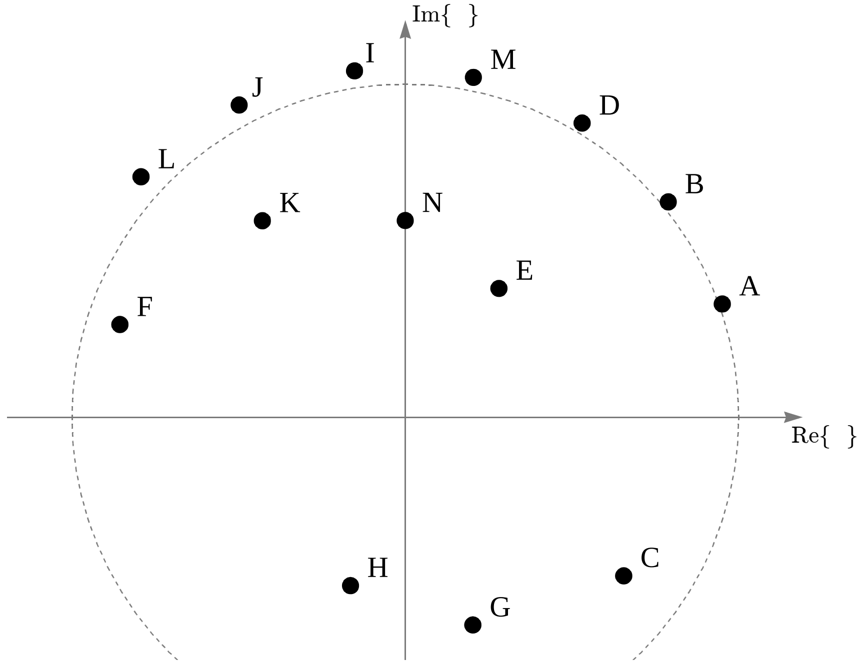
Problem	Value	Score Earned
1	25	
2	25	
3	25	
4	25	
No/Wrong Rec	–3	
Total		

PROB. Fall-12-Q1.1. Suppose $w = 0.9e^{j0.9\pi}$ and $z = \cos(0.1\pi) + j1.1\sin(0.1\pi)$.

(a) The sum in polar form is $w + z = Ae^{j\phi}$, where $A =$ [ ] and $\phi =$ [ ] radians.

(b) The ratio in rectangular form is $\frac{z}{w} = a + jb$, where $a =$ [ ] and $b =$ [ ].

The figure below shows the unit circle of radius one in the complex plane.
Also shown are the locations of $\{w, w^2, w^3, ..., w^7\}$ and $\{z, z^2, z^3, ..., z^7\}$ in the complex plane:



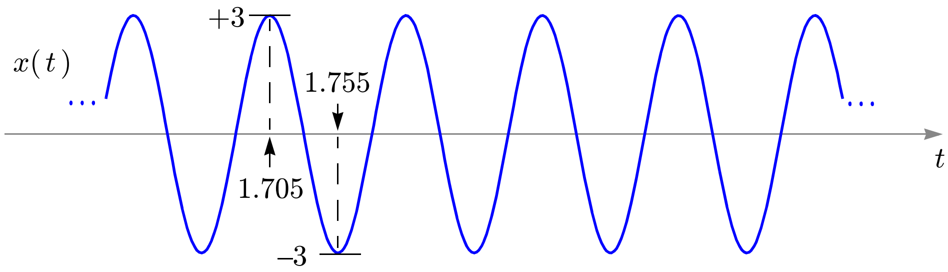
(c) Identify these locations by writing a letter (A, B, C, ... or N) in each answer box below.
[Hint: Do not consider each point separately. Look for a pattern.]

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
w	w^2	w^3	w^4	w^5	w^6	w^7

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
z	z^2	z^3	z^4	z^5	z^6	z^7

PROB. Fall-12-Q1.2.

(a) A sinusoidal signal $x(t)$ achieves a peak value of $+3$ at time $t = 1.705$, and a minimum value of –3 at time 1.755, as shown below:



In standard form we can write $x(t) = A\cos(\omega t + \theta)$, where:

$\omega = \square \geq 0$

$A = \square \geq 0$

$\theta = \square \in (-\pi, \pi]$.

(b) Consider the following MATLAB code:

```
tt = 0:0.001:dur; % dur is the duration in seconds
xt = real((-1-3j)*exp(j*22*pi*tt));
```

The variable `xt` represents a sinusoidal signal $x(t) = A\cos(\omega t + \theta)$ in standard form, where:

$\omega = \square \geq 0$

$A = \square \geq 0$

$\theta = \square \in (-\pi, \pi]$.

PROB. Fall-12-Q1.3. Solve the following equations for the real-valued unknowns ω, A, and θ. To make the answers unique, choose $\omega \geq 0$, $A \geq 0$, and $-\pi < \theta \leq \pi$.

(a) $3\cos(30\pi t + 0.2\pi) + \mathrm{Re}\{Ae^{j\theta}e^{j\omega t}\} = 3\cos(30\pi t + 0.3\pi)$.

$\omega =$ ______

$A =$ ______

$\theta =$ ______

(b) $\cos(\omega t + \theta) + \mathrm{Re}\{Ae^{j0.6\pi}e^{j88\pi t}\} = A\cos(88\pi(t - 0.1))$.

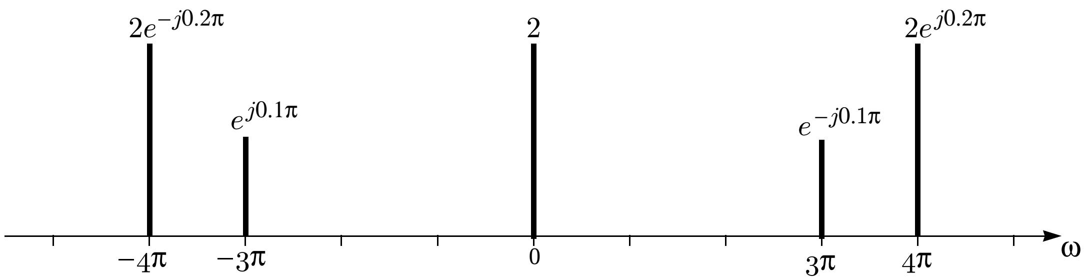
$\omega =$ ______

$A =$ ______

$\theta =$ ______

PROB. Fall-12-Q1.4.

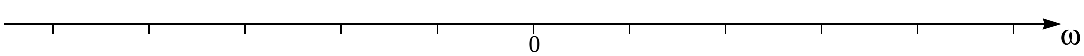
Shown below is the two-sided spectrum for a signal $x(t)$:



(a) We can write $x(t) = A_1\cos(\omega_1 t + \theta_1) + A_2\cos(\omega_2 t + \theta_2) + A_3\cos(\omega_3 t + \theta_3)$, where:

$\omega_1 =$	$\omega_2 =$	$\omega_3 =$
$A_1 =$	$A_2 =$	$A_3 =$
$\theta_1 =$	$\theta_2 =$	$\theta_3 =$

(b) *Carefully* sketch the two-sided spectrum for the delayed signal $s(t) = x(t - 0.2)$, taking care to **label** both the frequency and complex amplitude for each spectral line:



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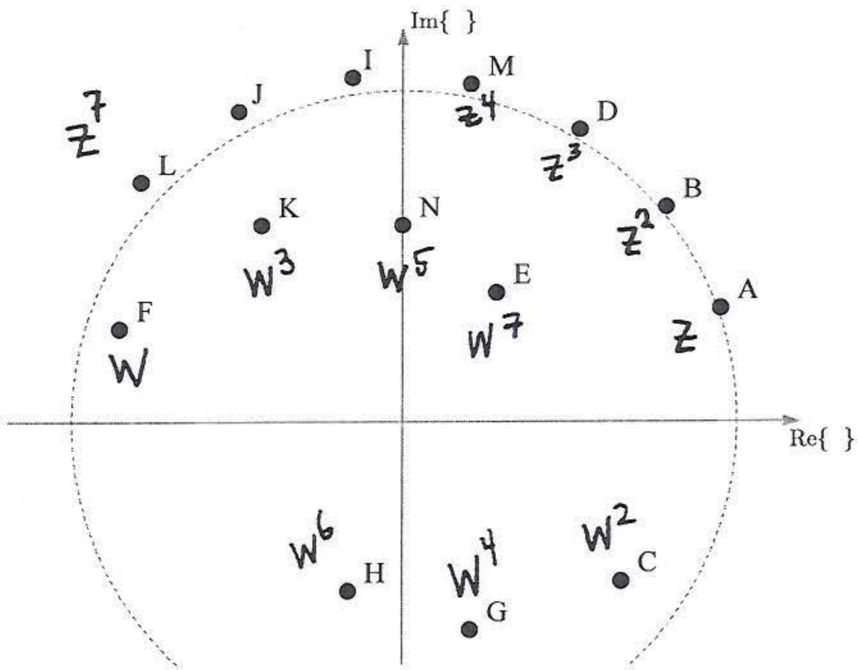
4	25	
No/Wrong Rec	–3	
Total		

PROB. Fall-12-Q1.1. Suppose $w = 0.9e^{j0.9\pi}$ and $z = \cos(0.1\pi) + j1.1\sin(0.1\pi)$.

(a) The sum in polar form is $w + z = Ae^{j\phi}$, where $A =$ [0.625] and $\phi =$ [0.45π] radians.
= 1.42 = 81.3°

(b) The ratio in rectangular form is $\frac{z}{w} = a + jb$, where $a =$ [-0.888] and $b =$ [-0.686].

The figure below shows the unit circle of radius one in the complex plane.
Also shown are the locations of $\{w, w^2, w^3, ..., w^7\}$ and $\{z, z^2, z^3, ..., z^7\}$ in the complex plane:



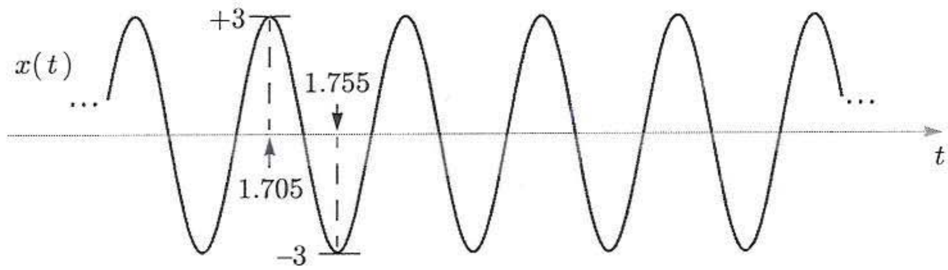
(c) Identify these locations by writing a letter (A, B, C, ... or N) in each answer box below.
[Hint: Do not consider each point separately. Look for a pattern.]

w	w^2	w^3	w^4	w^5	w^6	w^7
F	C	K	G	N	H	E

z	z^2	z^3	z^4	z^5	z^6	z^7
A	B	D	M	I	J	L

PROB. Fall-12-Q1.2.

(a) A sinusoidal signal $x(t)$ achieves a peak value of $+3$ at time $t = 1.705$, and a minimum value of -3 at time 1.755, as shown below:



In standard form we can write $x(t) = A\cos(\omega t + \theta)$, where:

$\omega =$ 20π ≥ 0

$A =$ 3 ≥ 0

$\theta =$ -0.1π $\in (-\pi, \pi]$.

$T = 2(1.755 - 1.705)$
$= 2(0.05)$
$= 0.1$
$\Rightarrow \omega = \frac{2\pi}{T} = 20\pi$

$\cos(20\pi(t - 1.705))$ $\Rightarrow \theta = -20\pi(1.705)$
$= -34.1\pi$
$\doteq -0.1\pi$

(b) Consider the following MATLAB code:

```
tt = 0:0.001:dur; % dur is the duration in seconds
xt = real((-1-3j)*exp(j*22*pi*tt));
```

The variable xt represents a sinusoidal signal $x(t) = A\cos(\omega t + \theta)$ in standard form, where:

$\omega =$ 22π ≥ 0

$A =$ $\sqrt{10} = 3.16$ ≥ 0

$\theta =$ -0.6π $\in (-\pi, \pi]$.

$= -1.89 = -108.4°$

$-1 - 3j = Ae^{j\theta}$

PROB. Fall-12-Q1.3. Solve the following equations for the real-valued unknowns ω, A, and θ.
To make the answers unique, choose $\omega \geq 0$, $A \geq 0$, and $-\pi < \theta \leq \pi$.

(a) $3\cos(30\pi t + 0.2\pi) + \text{Re}\{Ae^{j\theta}e^{j\omega t}\} = 3\cos(30\pi t + 0.3\pi)$.

$\omega =$ 30π

$A =$ 0.939

$\theta =$ 0.75π

$= 2.356 = 135°$

$$3e^{j0.2\pi} + Ae^{j\theta} = 3e^{j0.3\pi}$$

$$\Rightarrow Ae^{j\theta} = 3e^{j0.3\pi} - 3e^{j0.2\pi} = 0.939e^{j\frac{3\pi}{4}}$$

(b) $\cos(\omega t + \theta) + \text{Re}\{Ae^{j0.6\pi}e^{j88\pi t}\} = A\cos(88\pi(t - 0.1))$.

$\omega =$ 88π

$A =$ 0.618

$\theta =$ -0.6π

$= -1.89 = -108°$

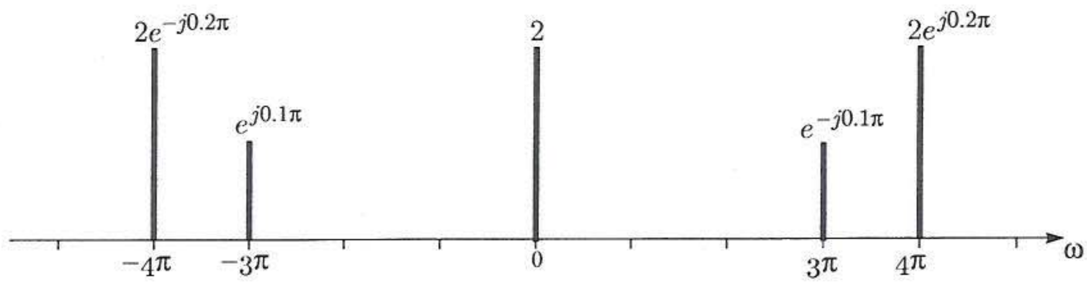
$$e^{j\theta} + Ae^{j0.6\pi} = Ae^{-j8.8\pi}$$

$$\Rightarrow \frac{1}{A}e^{j\theta} = e^{-j0.8\pi} - e^{j0.6\pi} = 1.618e^{-j0.6\pi}$$

$$\Rightarrow A = \frac{1}{1.618} = 0.618$$

PROB. Fall-12-Q1.4.

Shown below is the two-sided spectrum for a signal $x(t)$:

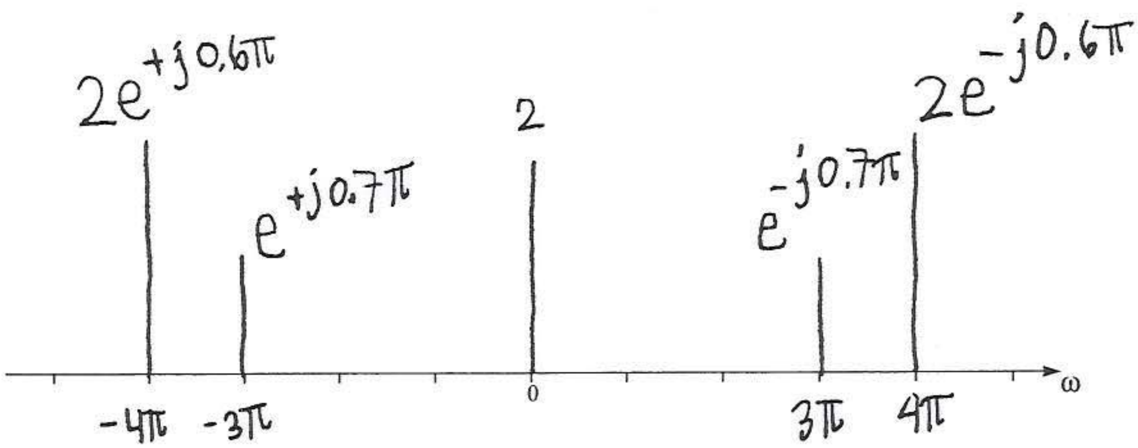


(a) We can write $x(t) = A_1\cos(\omega_1 t + \theta_1) + A_2\cos(\omega_2 t + \theta_2) + A_3\cos(\omega_3 t + \theta_3)$, where:

$\omega_1 =$ 0	$\omega_2 =$ 3π	$\omega_3 =$ 4π
$A_1^{*} =$ 2	$A_2 =$ 2	$A_3 =$ 4
$\theta_1 =$ 0	$\theta_2 =$ -0.1π	$\theta_3 =$ 0.2π

* $\frac{2}{\cos\theta_1}$ is OK

(b) *Carefully* sketch the two-sided spectrum for the delayed signal $s(t) = x(t - 0.2)$, taking care to **label** both the frequency and complex amplitude for each spectral line:



$$\Delta\theta = -\omega(0.2) = \begin{cases} -0.6\pi & @\ 3\pi \\ -0.8\pi & @\ 4\pi \end{cases}$$