GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL & COMPUTER ENGINEERING

ECE2026 – Spring 2025
Quiz #1
September 15, 2025

NAME: ______________________________ **GT Username:** _______________________
LAST **FIRST** **(e.g., gtinit0101)**

Important Notes:

- Write your name on each page.
- Closed book, but a calculator is permitted.
- One page (8.5"x11") of **HAND-WRITTEN** notes permitted. OK to write on both sides.
- Partial credit for incorrect answers may be granted ONLY when you JUSTIFY your correct reasoning CLEARLY.
- 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 previous pages.

PROBLEM Fall-25-Q.1.1.1:

Many signals can be expressed as sum of sinusoids as

$$x(t) = A_0 + \sum_{k=1}^{N} A_k \, cos(\,\omega_k t + \phi_k)$$

where $A_k \geq 0,\ -\pi < \phi_k \leq \pi$ for $k = 1,2,..,N$, and all ω_ks are distinct. This is often called a canonical or standard form. Reduce the following signals to their canonical form.

(a) $x_1(t) = 4\,cos(\,20\pi(t - \frac{1}{6})) - 4\,sin(\,20\pi t - \frac{15\pi}{6})$

$$x_1(t) = 4\,cos(\,20\pi t - \frac{10\pi}{3}) - 4\,sin(\,20\pi t - \frac{\pi}{2})$$

$$x_1(t) = 4\,cos(\,20\pi t + \frac{2\pi}{3}) + 4\,cos(\,20\pi t)$$

$$4e^{j2\pi/3} + 4 = 4e^{j\pi/3}$$

$x_1(t) = 4\,cos(\,20\pi t + \pi/3)$

(b) $x_2(t) = \sum_{k=0}^{2} 2(k+1)\,cos(\,50k\pi t + \frac{k\pi}{4}) + 4\,cos(\,50\pi t - \frac{\pi}{4})$.

$$x_2(t) = \sum_{k=0}^{2} 2(k+1)\,cos(\,50k\pi t + \frac{k\pi}{4}) + 4\,cos(\,50\pi t - \frac{\pi}{4})$$

$$= 2 + 4\cos\,(50\pi t + \frac{\pi}{4}) + 6\cos\,(100\pi t + \frac{\pi}{2}) + 4\cos\,(50\pi t - \frac{\pi}{4})$$

$$4e^{j\pi/4} + 4e^{-j\pi/4} = 8\,cos(\,\pi/4) = 4\sqrt{2}$$

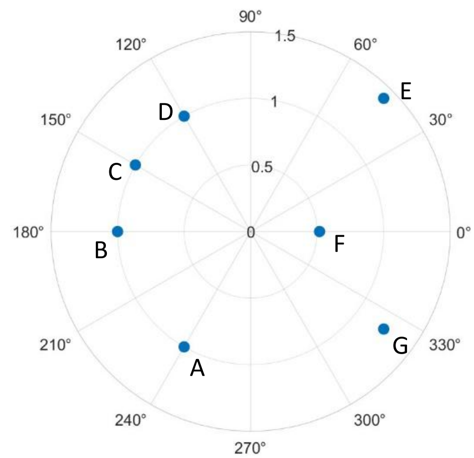
$$x_2(t) = 2 + 4\sqrt{2}\,cos(\,50\pi t) + 6\,cos(\,100\pi t + \frac{\pi}{2})$$

$x_2(t) = 2 + 4\sqrt{2}\,cos(\,50\pi t) + 6\,cos(\,100\pi t + \frac{\pi}{2})$

PROBLEM Fall-25-Q.1.1.2:

Let $z_1 = e^{-j\pi/3}$, but z_2 is to be found from the provided clue. Find the corresponding solid (filled) point in the plot, designated in capital letter, for each of the expressions in the table below. (Note a point may correspond to multiple expressions.)

$z = z_1^* z_2/\lvert z_1 \rvert$	C
$z = z_1^2$	A
$z = \lvert z_1 + z_2 \rvert$	F
$z = z_1^2/z_1^*$	B
$z = z_1^* z_1^*$	D
$z = z_1 z_1^* + z_2$	E
$z = 2z_1 + z_2$	G
$z = z_2^2$	B



From the given answer of C, it is found that $z_2 = j$

PROBLEM Fall-25-Q.1.1.3:

The following MATLAB code generates a sinusoidal signal once **zx**, a single complex number, is defined.

```
tt = -0.1 : 1/10240 : 0.1;
Fo = 16;
zx = ??;
zz = zx*exp(j*(2*pi*Fo*tt + pi/4));
xx = real( zz );
```

When the entire signal **xx** is plotted, it is observed that the signal attains a positive peak with value 3 at **tt(345)**.

Now give answers to the following:

(a) What is the length of **xx**?

(b) Find **zx**.

(c) Write a mathematical expression for the real signal $x(t)$ that corresponds to the signal array **xx**.

Answers:

a) With $-0.1 \leq t \leq 0.1$, a time span of 0.2s, and a time increment of 1/10240 represented in the **tt** array, we have 0.2x10240 = 2048 increments altogether. Counting the two endpoints, we conclude that the length of **tt** is 2049, with **tt(1)=-0.1** and with **tt(2049)=0.1.** The data array **xx** has the same length as 2049.

b) Given **Fo = 16**, we have period $T = \frac{1}{f_0} = \frac{1}{16}$. A peak occurs at **tt(345)**, which corresponds to $t = \frac{344}{10240} - 0.1 = -\frac{68}{1024}$. To find the phase, we recognize the fact that $\cos\theta$ attains its peak value when $\theta = 0$. Note that the code for **zz** already has **pi/4**, therefore to find the phase, we invoke $\omega t_m + \frac{\pi}{4} + \varphi = 0$ and obtain $\varphi = -2\pi \times 16 \times \left(-\frac{68}{1024}\right) - \frac{\pi}{4} = \frac{15\pi}{8}$ or $-\frac{\pi}{8}$. Peak value is 3, $|z_x| = 3$. Therefore, **zx = 3*exp(-j*pi/8)**

c) Finally the signal's phase is $\frac{\pi}{8} + \frac{\pi}{4} = \frac{3\pi}{8}$, $x(t) = 3\,cos(\,32\pi t + \frac{3\pi}{8})$

Answers:

(a) Length is 2049;

(b) **zx = 3*exp(-j*pi/8)**

(c) $x(t) = 3\,cos(\,32\pi t + \frac{3\pi}{8})$