GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL of ELECTRICAL & COMPUTER ENGINEERING

QUIZ #2

DATE: 25-Feb-11 COURSE: ECE-2025

NAME: _____ GT username: _____

LAST, FIRST (ex: gpburdell3)

3 points | 3 points | 3 points

Recitation Section: Circle the date & time when your **Recitation Section** meets (not Lab):

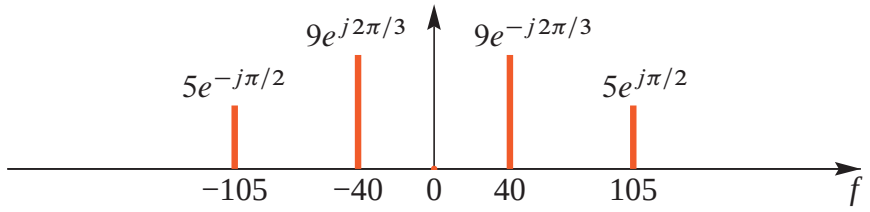
	L05:Tues-Noon (Stüber)		L06:Thur-Noon (Bhatti)
	L07:Tues-1:30pm (Stüber)		L08:Thur-1:30pm (Bhatti)
L01:M-3pm (McClellan)	L09:Tues-3pm (Lee)	L02:W-3pm (Chang)	L10:Thur-3pm (Madisetti)
L03:M-4:30pm (Lee)	L11:Tues-4:30pm (Lee)	L04:W-4:30pm (Chang)	

- Write your name on the front page ONLY. **DO NOT** unstaple the test.
- Closed book, but a calculator is permitted.
- One page ($8\frac{1}{2}'' \times 11''$) of **HAND-WRITTEN** notes permitted. OK to write on both sides.
- **JUSTIFY** your reasoning CLEARLY to receive partial credit.
  Explanations are also required to receive **FULL** credit for any answer.
- 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 space is needed for scratch work, use the backs of previous pages.

Problem	*Value*	*Score*
1	30	
2	40	
3	30	
No/Wrong Rec	−3	

PROBLEM Spring-10-Q.2.1:

The two-sided spectrum representation of a real-valued signal $x_1(t)$ is shown below (frequency in hertz):



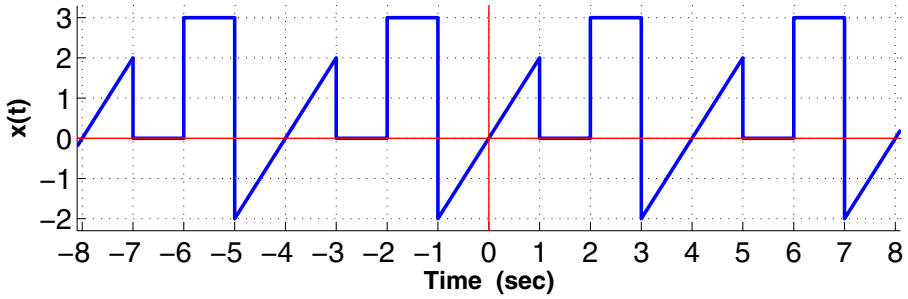
(a) Write the formula for $x_1(t)$ as a sum of real-valued sinusoids.

(b) The signal $x_2(t) = x_1(t - 1/15)$ is a time-delayed version of $x_1(t)$. Make a *well-labeled* sketch of the spectrum of $x_2(t)$. Simplify the numerical values for the complex amplitudes, i.e., phases should be in $[-\pi, \pi]$.

(c) A third signal is defined as $x_3(t) = x_1(t)\, e^{j\,80\pi t}$. In other words, it is formed by multiplying the original $x_1(t)$ by a complex exponential. This new signal is *complex-valued*, and it has a nonzero DC component. Determine the complex amplitude for the DC component of $x_3(t)$.

PROBLEM Spring-10-Q.2.2:

Suppose that a periodic signal $x(t)$ is defined by the plot below (only the section $-8 \le t \le 8$ is shown):



(a) Determine the **fundamental frequency** of $x(t)$ in ***radians/sec***.

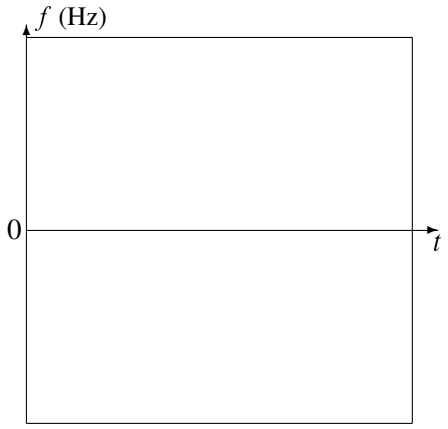
$\omega_0 =$

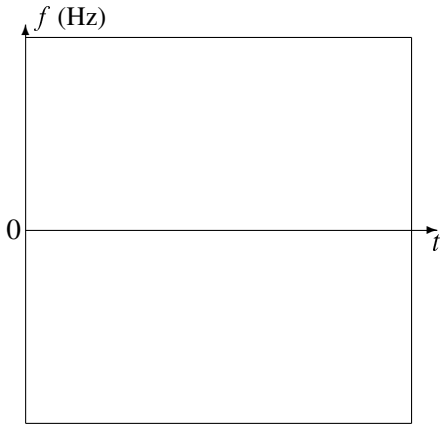
(b) Since $x(t)$ is periodic, it has a Fourier Series, $\sum_{k=-\infty}^{\infty} a_k e^{j\omega_0 k t}$. Determine the numerical value of a_0.

$a_0 =$

(c), (d) Make *carefully labeled* sketches of the two-sided spectrograms of the signals $b(t)$ and $c(t)$ over the interval $0 \le t \le 1$ sec:

$b(t) = \cos(1200\pi t)\sin(200\pi t)$ and $c(t) = \cos(1000\cos(\pi t))$





PROBLEM Spring-10-Q.2.3:

For each short question, pick a correct frequency **(from the list on the right only)** and enter the number in the answer box[1]: *Explain/Justify your answers.*

Question

(a) If the following MATLAB code is implemented, what is the frequency of the sound that will be produced at the output of the computer's D-to-A converter.

```
soundsc( cos(1.2*pi*(0:65536)), 1000);
```

ANS =

Frequency

4000 Hz

2000 Hz

1500 Hz

800 Hz

600 Hz

500 Hz

400 Hz

250 Hz

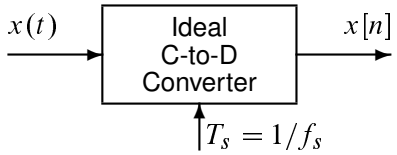
200 Hz

(b) Determine the Nyquist rate for sampling the signal $x(t)$ defined by: $x(t) = \cos(700\pi t)\sin(800\pi t)$.

ANS =

(c) If the C/D converter output is $x[n] = A\cos(0.75\pi n)$, and the sampling rate is 1600 samples/sec, then determine one possible value for the input frequency of $x(t)$:

ANS =



[1] It is possible to use an answer more than once.

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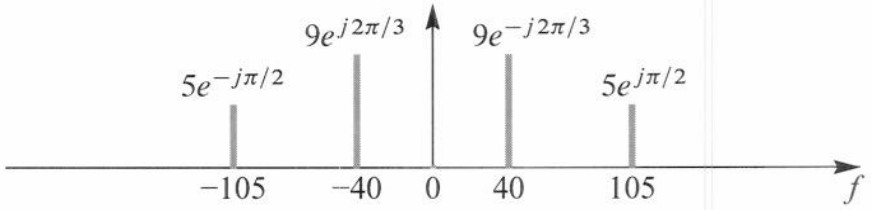
No/Wrong Rec	−3	

PROBLEM Spring-10-Q.2.1:

The two-sided spectrum representation of a real-valued signal $x_1(t)$ is shown below (frequency in hertz):



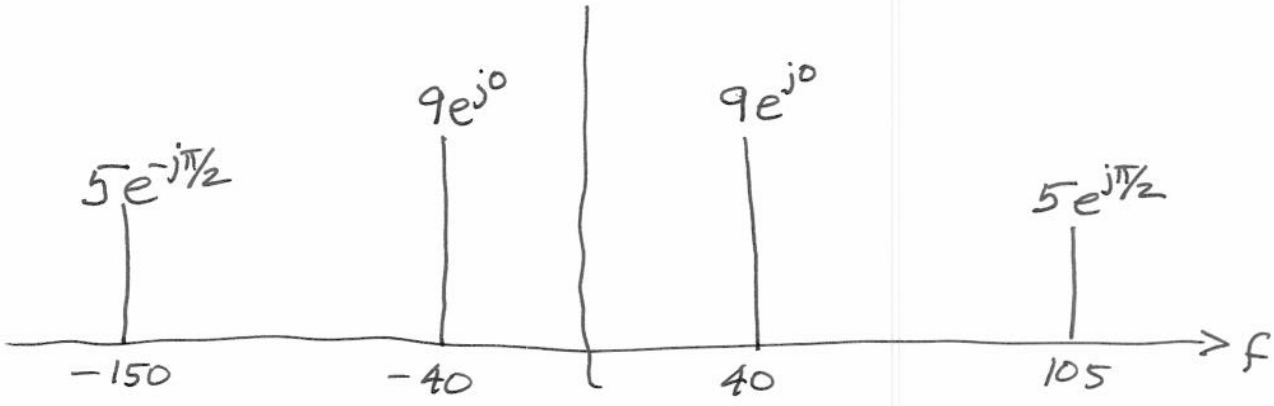
(a) Write the formula for $x_1(t)$ as a sum of real-valued sinusoids.

$x_1(t) = 18\cos(80\pi t - 2\pi/3) + 10\cos(210\pi t + \pi/2)$

(b) The signal $x_2(t) = x_1(t - 1/15)$ is a time-delayed version of $x_1(t)$. Make a *well-labeled* sketch of the spectrum of $x_2(t)$. Simplify the numerical values for the complex amplitudes, i.e., phases should be in $[-\pi, \pi]$.

$80\pi(t - 1/15) = 80\pi t - \frac{16\pi}{3}$ ← $-4\pi/3 - 2\pi/3 = -6\pi/3 \rightarrow 0$

$210\pi(t - 1/15) = 210\pi t - 14\pi \rightarrow 0 + \pi/2$

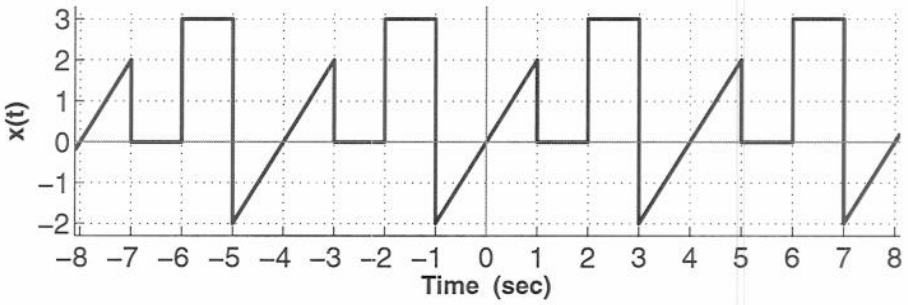


(c) A third signal is defined as $x_3(t) = x_1(t)e^{j80\pi t}$. In other words, it is formed by multiplying the original $x_1(t)$ by a complex exponential. This new signal is *complex-valued*, and it has a nonzero DC component. Determine the complex amplitude for the DC component of $x_3(t)$.

ANS = $9e^{j2\pi/3}$

PROBLEM Spring-10-Q.2.2:

Suppose that a periodic signal $x(t)$ is defined by the plot below (only the section $-8 \le t \le 8$ is shown):



(a) Determine the **fundamental frequency** of $x(t)$ in ***radians/sec***.

$\omega_0 = 2\pi/4 = \pi/2$ $\quad T = 4$

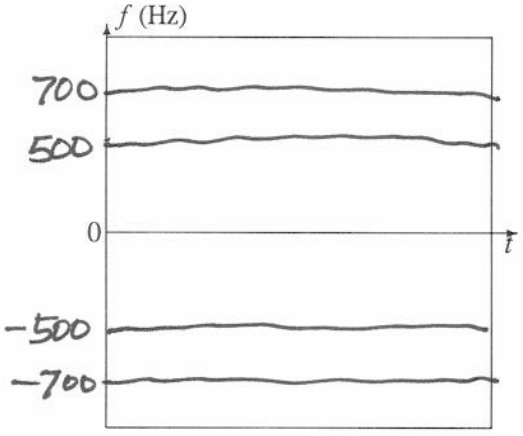
(b) Since $x(t)$ is periodic, it has a Fourier Series, $\sum_{k=-\infty}^{\infty} a_k e^{j\omega_0 k t}$. Determine the numerical value of a_0.

$a_0 = 3/4$

$$a_0 = \frac{1}{4}\left((1)(3) + \frac{1}{2}(1)(2) + \frac{1}{2}(1)(-2)\right) = 3/4$$

(c), (d) Make *carefully labeled* sketches of the two-sided spectrograms of the signals $b(t)$ and $c(t)$ over the interval $0 \le t \le 1$ sec:

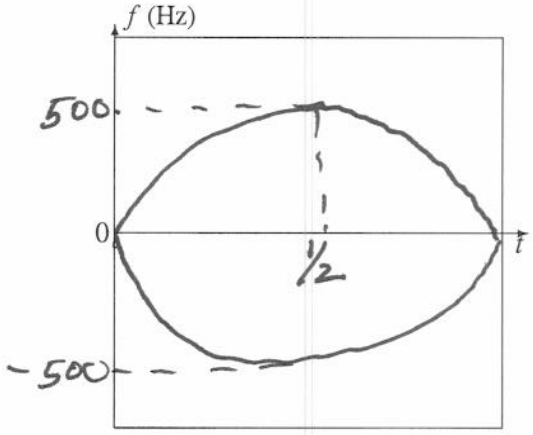
$b(t) = \cos(1200\pi t)\sin(200\pi t)$ and $c(t) = \cos(1000\cos(\pi t))$



Sum & Diff

$1400\pi \rightarrow 700$ Hz

$1000\pi \rightarrow 500$ Hz



$\frac{d}{dt}\psi(t) = 1000\pi \sin(\pi t)$

$\uparrow$ 500

PROBLEM Spring-10-Q.2.3:

For each short question, pick a correct frequency **(from the list on the right only)** and enter the number in the answer box[3]: *Explain/Justify your answers.*

Question

(a) If the following MATLAB code is implemented, what is the frequency of the sound that will be produced at the output of the computer's D-to-A converter.

```
soundsc( cos(1.2*pi*(0:65536)), 1000);
```

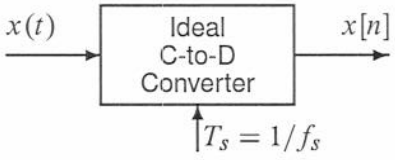
ANS = 400

(b) Determine the Nyquist rate for sampling the signal $x(t)$ defined by: $x(t) = \cos(700\pi t)\sin(800\pi t)$.

ANS = 1500

(c) If the C/D converter output is $x[n] = A\cos(0.75\pi n)$, and the sampling rate is 1600 samples/sec, then determine one possible value for the input frequency of $x(t)$:

ANS = 600



Frequency

4000 Hz

2000 Hz

1500 Hz

800 Hz

600 Hz

500 Hz

400 Hz

250 Hz

200 Hz

[3]It is possible to use an answer more than once.