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):

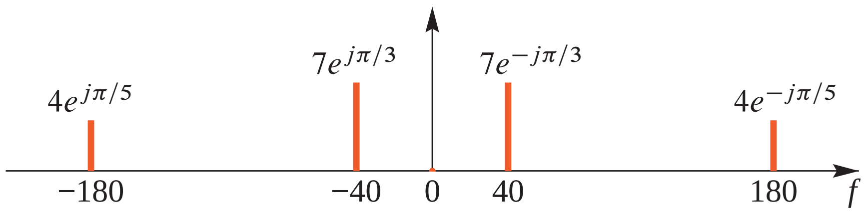
	L05:Tues-Noon (Stüber)		L06:Thur-Noon (Bhatti)
	L07:Tues-1:30pm (Stüber)		L08:Thur-1:30pm (Bhatti)
L01:M-3pm (McClellan)	L09:Tues-3pm (Lee)	L02:W-3pm (Chang)	L10:Thur-3pm (Madisetti)
L03:M-4:30pm (Lee)	L11:Tues-4:30pm (Lee)	L04:W-4:30pm (Chang)	

- 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 sp-10-Q.2.1:

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



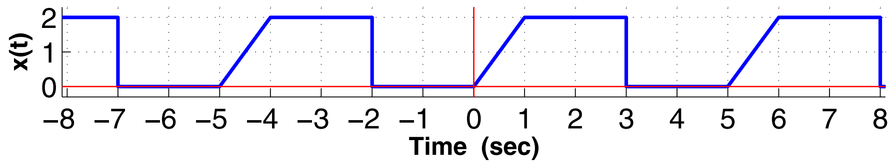
(a) Write the formula for $x_1(t)$ as a sum of real-valued sinusoids.

(b) The signal $x_2(t) = x_1(t - 1/60)$ 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 $x_3(t) = x_1(t)e^{j80\pi t}$. 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 $x_3(t)$.

PROBLEM sp-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***.

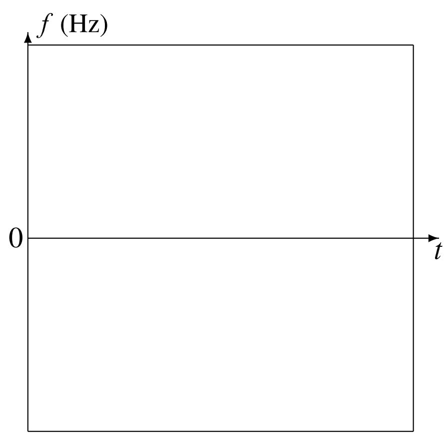
$\boxed{\omega_0 = \quad}$

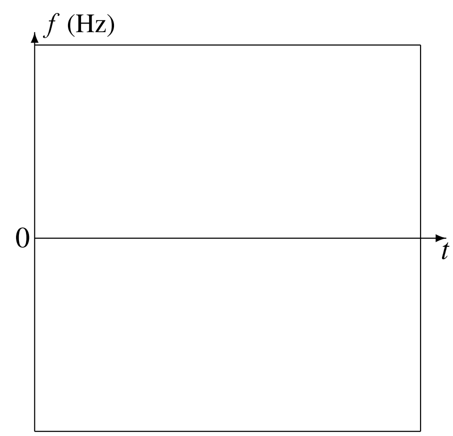
(b) Since $x(t)$ is periodic, it has a Fourier Series, $\sum\limits_{k=-\infty}^{\infty} a_k e^{j\omega_0 k t}$. Determine the numerical value of a_0.

$\boxed{a_0 = \quad}$

(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:

$b(t) = \cos(10\pi t)\sin(50\pi t)$ and $c(t) = \cos(40\sin(0.5\pi t))$





PROBLEM sp-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.*

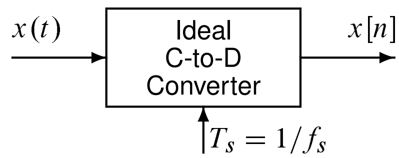
Question

Frequency

- 8000 Hz
- 4000 Hz
- 2000 Hz
- 1600 Hz
- 1200 Hz
- 1000 Hz
- 800 Hz
- 500 Hz
- 400 Hz

(a) If the C/D converter output is $x[n] = 7\cos(0.5\pi n)$, and the sampling rate is 2000 samples/sec, then determine one possible value for the input frequency of $x(t)$:

ANS =



(b) 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(1.6*pi*(0:9999)), 2500);
```

ANS =

(c) Determine the Nyquist rate for sampling the signal $x(t)$ defined by: $x(t) = \cos(400\pi t)\sin(100\pi t)$.

ANS =

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

GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL of ELECTRICAL & COMPUTER ENGINEERING

QUIZ #2

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

NAME: Version – 1 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):

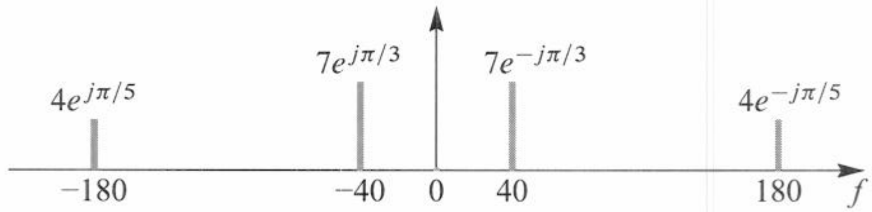
	L05:Tues-Noon (Stüber)		L06:Thur-Noon (Bhatti)
	L07:Tues-1:30pm (Stüber)		L08:Thur-1:30pm (Bhatti)
L01:M-3pm (McClellan)	L09:Tues-3pm (Lee)	L02:W-3pm (Chang)	L10:Thur-3pm (Madisetti)
L03:M-4:30pm (Lee)	L11:Tues-4:30pm (Lee)	L04:W-4:30pm (Chang)	

- 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 sp-10-Q.2.1:

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



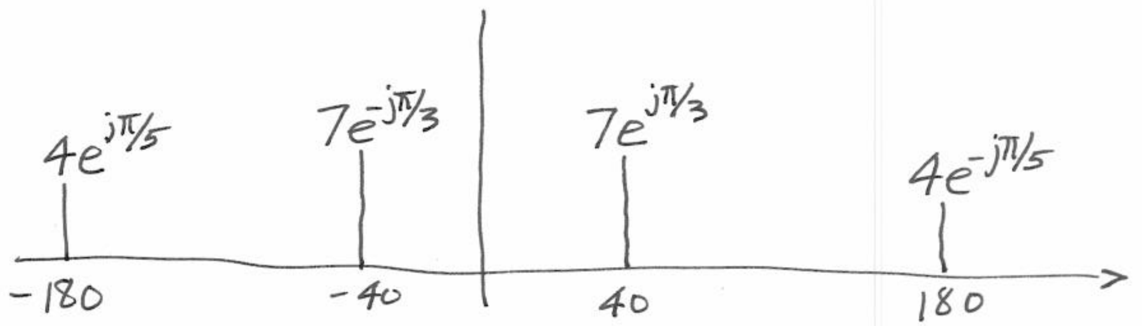
(a) Write the formula for $x_1(t)$ as a sum of real-valued sinusoids.

$$x_1(t) = 14\cos(80\pi t - \pi/3) + 8\cos(360\pi t - \pi/5)$$

(b) The signal $x_2(t) = x_1(t - 1/60)$ 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 $[-\pi, \pi]$.

$$x_2(t) = 14\cos(\underbrace{80\pi(t - 1/60)}_{-80\pi/60 \,=\, -4\pi/3} - \pi/3) + 8\cos(360\pi(t - 1/60) - \pi/5)$$

$$-5\pi/3 \to \pi/3 \qquad\qquad \frac{-360\pi}{60} = -6\pi \to 0$$



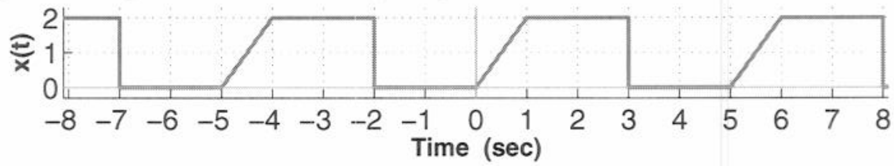
(c) A third signal is defined as $x_3(t) = x_1(t)\,e^{j80\pi t}$. In other words, it is formed by multiplying the original $x_1(t)$ by a complex exponential. This new signal is *complex-valued*, and it has a nonzero DC component. Determine the complex amplitude for the DC component of $x_3(t)$.

The term $\left(7e^{j\pi/3} e^{-j80\pi t}\right) e^{j80\pi t} \longrightarrow$ DC.

$\therefore$ ANS $= 7e^{j\pi/3}$

PROBLEM sp-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***.

$\boxed{\omega_0 = 2\pi/5}$

$T = 5$

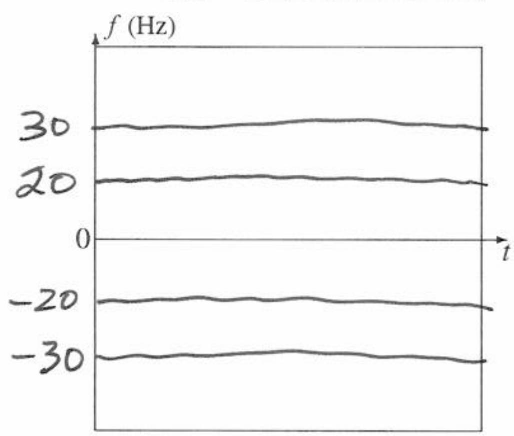
(b) Since $x(t)$ is periodic, it has a Fourier Series, $\sum_{k=-\infty}^{\infty} a_k e^{j\omega_0 k t}$. Determine the numerical value of a_0.

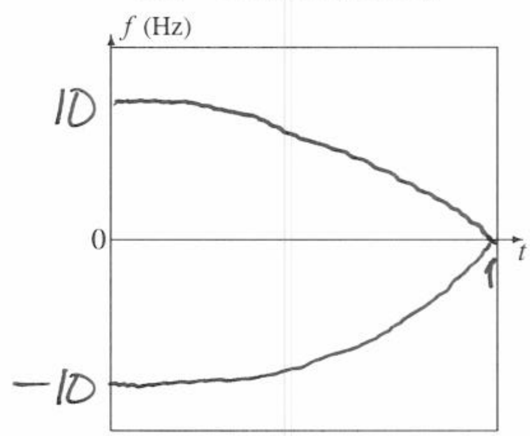
$\boxed{a_0 = 1}$

$a_0 = \frac{1}{T}\text{Area} = \frac{1}{5}\left(\frac{1}{2}(1)(2) + (2)(2)\right) = 1$

(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:

$b(t) = \cos(10\pi t)\sin(50\pi t)$ and $c(t) = \cos(40\sin(0.5\pi t))$





Sum & Diff.

$60\pi \to 30\text{ Hz}$

$40\pi \to 20\text{ Hz}$

$\frac{d}{dt}\psi(t) = 20\pi\cos(0.5\pi t)$

10 Hz

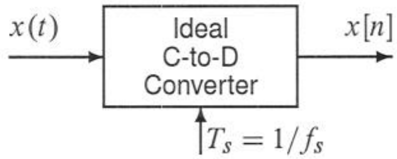
PROBLEM sp-10-Q.2.3:

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 C/D converter output is $x[n] = 7\cos(0.5\pi n)$, and the sampling rate is 2000 samples/sec, then determine one possible value for the input frequency of $x(t)$:

ANS = 500



(b) 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(1.6*pi*(0:9999)), 2500);
```

ANS = 500

(c) Determine the Nyquist rate for sampling the signal $x(t)$ defined by: $x(t) = \cos(400\pi t)\sin(100\pi t)$.

ANS = 500

Frequency

- 8000 Hz
- 4000 Hz
- 2000 Hz
- 1600 Hz
- 1200 Hz
- 1000 Hz
- 800 Hz
- 500 Hz
- 400 Hz

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