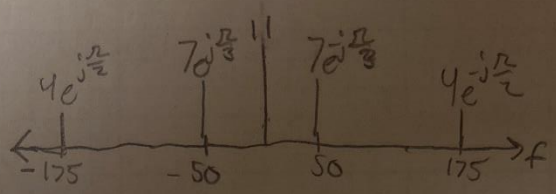
P.S.4-Problem #1 - P.3.1(b)

Given:

$x(t) =$ 

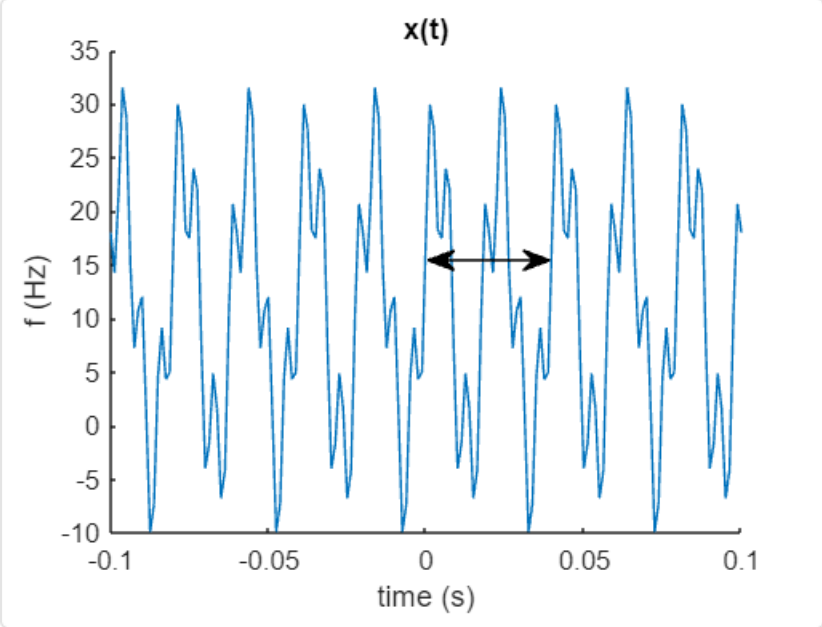
Find: if $x(t)$ is a periodic signal. If so find it's fundamental period and fundamental frequency

Solution:

$$x(t) = 11 + 14\cos(2\pi(50)t - \tfrac{\pi}{3}) + 8\cos(2\pi(175)t - \tfrac{\pi}{2})$$

Yes, it is a periodic signal. The gcd of 0, 50, & 175 is 25, meaning the fundamental freq. equals 25Hz and the fund. period ($T_o = \frac{1}{f_o}$) is 0.04s or 40ms.

$f_o = 25Hz \quad T_o = 0.04_s = 40ms$




```
f = 800;
tt = -0.1:1/f:0.1;
x = 11 + 14 * cos((2*pi *50 * tt ) -(pi /3)) + 8 *cos((2 * pi * 175 * tt) - ( pi
/ 2))
hold on
plot(tt,x)
xlabel('time (s)')
ylabel('f (Hz)')
title('x(t)')


annotation('doublearrow', [0.52 0.67], [0.58, 0.58])
```

PS4 - Problem 2 - P.3.2 (b)(c)

Given:

$$x(t) = 10\cos(800\pi t + \pi/4) + 7\cos(1200\pi t - \pi/3) - 3\cos(1600\pi t)$$

$$y(t) = x(t) + 5\cos(1000\pi t + \pi/2)$$

Find: If $x(t)$ and/or $y(t)$ are periodic and if yes, their fundamental period.

Solution:

$$x(t) = 10\cos(2\pi(400)t + \pi/4) + 7\cos(2\pi(600)t - \pi/3) - 3\cos(2\pi(800)t)$$

$f_{xk} = \{400, 600, 800\}$ $\quad \gcd[f_{xk}] = 200$

$x(t)$ is periodic w/ a f_0 of 200 Hz

$$y(t) = x(t) - 5\cos(2\pi(500)t + \pi/2)$$

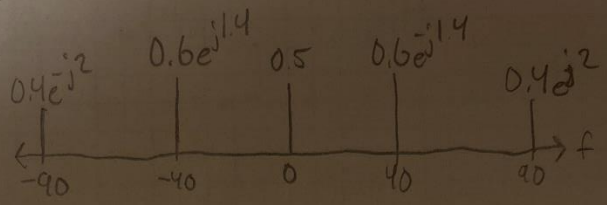
$f_{yk} = f_{xk} + \{500\}$ $\quad \gcd[f_{yk}] = 100$

$y(t)$ is periodic w/ a f_0 of 100 Hz

P.S.4 - Problem 3 - P. 3.20(a)(b)(c)

Given:

$x(t) =$



Find:

a: Fundamental freq. of $x(t)$ b: Fundamental period of $x(t)$

c: DC value of $x(t)$

Solution:

a:

$f_k = \{-90, 40, 0\}$ $\gcd[f_k] = 10$

The fundamental frequency is 10Hz

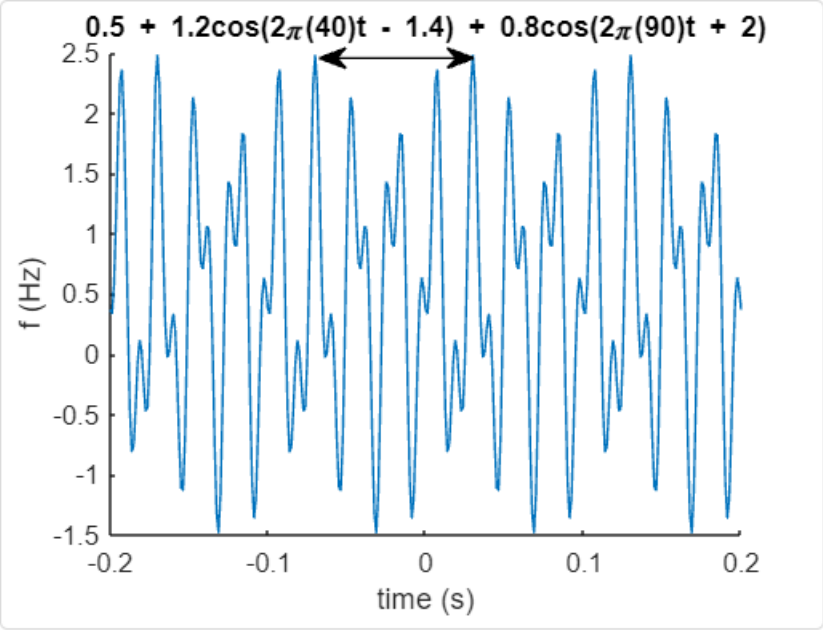
b:

$T_0 = \frac{1}{f_0} = \frac{1}{10} = 0.1$

The fundamental period is 0.1s or 100ms

c:

The DC offset is 0.5




```
f = 800;
tt = -0.2:1/f:0.2;
x = 0.5 + 1.2 * cos((2 * pi * 40 * tt) - 1.4) + 0.8 * cos((2 * pi * 90 * tt) + 2)
hold on
plot(tt,x)
xlabel('time (s)')
ylabel('f (Hz)')
title('0.5 + 1.2cos(2\pi(40)t - 1.4) + 0.8cos(2\pi(90)t + 2)')


annotation('doublearrow', [0.387 0.577], [0.915, 0.915])
hold off
```

P.S. 4-Problem 4-P3.26

Given:

The 5 images of waveforms and 5 of spectra

Find: which waveforms and spectra match and their sinusoid

Solution

Spectra:

1) $x = 4\cos(2\pi(3)t + \frac{\pi}{2}) + 4\cos(2\pi(2)t + \pi)$

$f_k = \{2, 3\}$ $\gcd[f_k] = 1\,Hz$ $f_0 = 1Hz$ $T = \frac{1}{f_0} = 1\,s$

2) $x = 4\cos(2\pi(3)t - \frac{\pi}{3}) + 2\cos(2\pi(2)t + \frac{\pi}{4})$

$f_0 = 1Hz$ $T_0 = 1\,s$

3) $x(t) = 3\cos(\pi) + 2\cos(2\pi(2) + \frac{\pi}{4}) = -3 + 2\cos(2\pi(2)t + \frac{\pi}{4})$

$f_k = \{2\}$ $f_0 = \gcd[f_k] = 2Hz$ $T_0 = \frac{1}{2} = 0.5s$

$max = 2 + (-3) = -1$ $min = -2 + (-3) = -5$ $Range = [-5, -1]$

4) $x(t) = 2\cos(\pi) + 4\cos(2\pi(2)t + \pi) = -2 + 4\cos(2\pi(2)t + \pi)$

$f_0 = 2Hz$ $T_0 = 0.5s$ $max = 4 - 2 = 2$ $min = -4 - 2 = -6$ $Range = [-6, 2]$

5) $x(t) = 4\cos(2\pi t + \pi) + 4\cos(2\pi(2)t + \pi)$

$f_k = \{1, 2\}$ $f_0 = \gcd[f_k] = 1Hz$ $T_0 = 1\,s$

Waveforms

#	T_0	Range	notes
a	0.5	[5, -1]	$x(0) \neq 0$, max $\varphi \neq 0, \pi, 2\pi$, perfect sinusoid
b	1	[-6, 8]	$\varphi \neq 0, \pi, 2\pi$ looks like it would be perfect sin
c	1	[-6, 5]	$\varphi \neq 0, \pi, 2\pi$
d	1	[-8, 4]	$x(0) = min$, $\varphi = \pi$, $x(0) = -6$
e	0.5	[-1, -6]	$x(0) = min$, $\varphi = \pi$

P.S4-Problem 4-P.3.26

#	wave	spectra	x(t) sinusoid
I	e	4	$4\cos(2\pi(2)t+\pi)-2$
II	a	3	$2\cos(2\pi(2)t+\frac{\pi}{4})-3$
III	d	5	$4\cos(2\pi t+\pi)+4\cos(2\pi(2)x+\pi)$
IV	b	1	$4\cos(2\pi(3)t+\frac{\pi}{2})+4\cos(2\pi(2)t+\pi)$
V	c	2	$4\cos(2\pi(3)t-\frac{\pi}{3})+4\cos(2\pi(2)t+\frac{\pi}{4})$

Reasons

I) simple sinusoids, Ψ must equal $\pm\pi$, Range match, T_0 match

II) only other simple sinusoid, Range match, T_0 match

III) since $x(t)=0$; $\Psi_0=\pm\pi$, Ψ match, $x(0)=-8$

IV+V) between wave b + c, one has $x(0)$ = negative and the other has $x(0)$ = positive. from the sinusoids I derived I knew spectrum 2 has the negative, wave c, and spectrum 1 is wave b.