8.3 QUIZ QUESTION 1 (1/1 point)

Consider a cosinusoidal carrier with frequency 250Hz modulated by a cosinudoidal signal with frequency 25Hz and then mixed by another cosinusoidal signal at 250Hz. Denoting the output of the mixer by $Y(t)$, we have

$$Y(t) = \cos(2\pi \cdot 25t) \cdot \cos(2\pi \cdot 250t) \cdot \cos(2\pi \cdot 250t).$$

$Y(t)$ can also be written as the sum of six complex exponentials,

$$Y(t) = \sum_{i=1}^{6} A_i \exp(j2\pi f_i t)$$

where the components are numbered in order of increasing frequency, where f_1 is the lowest (most negative) frequency component and f_6 the highest (most positive). Give the magnitude and frequency of these complex exponentials. Give the amplitudes to three decimal places.

A_1 =

0.125 ✔ **Answer:** 0.125

0.125

f_1 =

-525 ✔ **Answer:** -525

-525

A_2 =

0.125 ✔ **Answer:** 0.125

0.125

f_2 =

-475 ✔ **Answer:** -475

-475

A_3 =

0.250 ✔ **Answer:** 0.25

0.250

f_3 =

-25 ✔ **Answer:** -25

-25

A_4 =

0.250 ✔ **Answer:** 0.25

0.250

f_4 =

25 ✔ **Answer:** 25

25

A_5 =

0.125 ✔ **Answer:** 0.125

0.125

f_5 =

475 ✔ **Answer:** 475

475

A_6 =

0.125 ✔ **Answer:** 0.125

0.125

f_6 =

525 ✔ **Answer:** 525

525

EXPLANATION

$$\begin{aligned} Y(t) &= \cos(2\pi \cdot 25t) \cdot \cos(2\pi \cdot 250t) \cdot \cos(2\pi \cdot 250t) \\ &= \cos(2\pi \cdot 25t) \cdot (0.5 + 0.5\cos(2\pi \cdot 500t)) \\ &= 0.5\cos(2\pi \cdot 25t) + 0.5\cos(2\pi \cdot 25t)\cos(2\pi \cdot 500t) \\ &= 0.5\cos(2\pi \cdot 25t) + 0.25\cos(2\pi \cdot 475t) + 0.25\cos(2\pi \cdot 525t) \end{aligned}$$

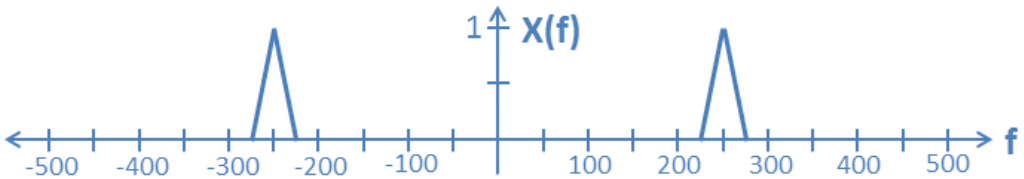
Since $\cos(x) = 0.5e^{-jx} + 0.5e^{jx}$,

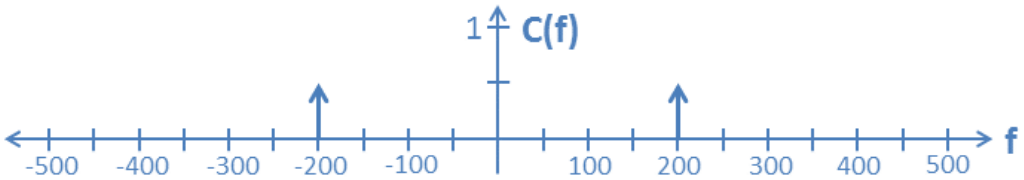
$$\begin{aligned} Y(t) = {} & 0.25e^{j2\pi\cdot(-25t)} + 0.25e^{j2\pi\cdot 25t} \\ & + 0.125e^{j2\pi\cdot(-475t)} + 0.125e^{j2\pi\cdot 475t} \\ & + 0.125e^{j2\pi\cdot(-525t)} + 0.125e^{j2\pi\cdot 525t} \end{aligned}$$

You have used 1 of 3 submissions

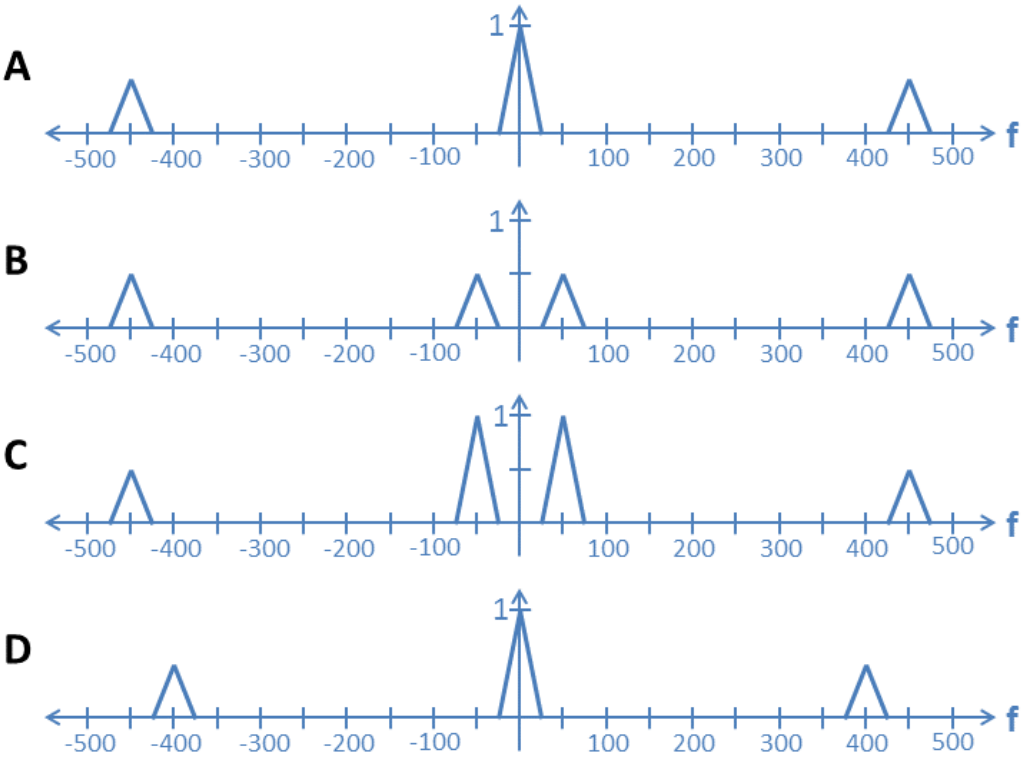
8.3 QUIZ QUESTION 2 (1/1 point)

Suppose that a transmitted signal $x(t)$ is created by taking a baseband signal and using it to modulate a cosine at 250Hz, resulting in the spectrum $X(f)$ shown below. Suppose that $x(t)$ is mixed with a cosine $c(t)$ with frequency 200Hz. The spectrum of the mixing cosine is shown below as $C(f)$. Note that the carrier frequency is not the same as the mixing frequency.





Consider the four amplitude spectra shown below.



Which of the spectra above is the spectrum of the final signal?

- Spectrum A
- Spectrum B ✔

- Spectrum C
- Spectrum D

EXPLANATION

Mixing the signal $x(t)$ with the cosine results in two copies of the spectrum $X(f)$ each with half the amplitude centered at -200Hz and 200Hz. Since $X(f)$ has triangular spectra located at -250Hz and +250Hz, this results in traingular spectra located at -450Hz,50Hz,-50Hz and 450Hz.

You have used 1 of 2 submissions