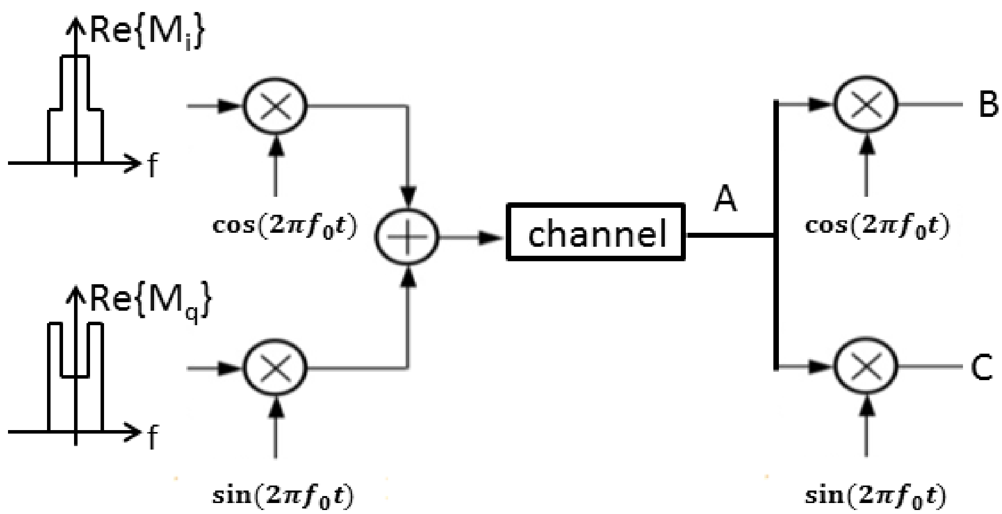
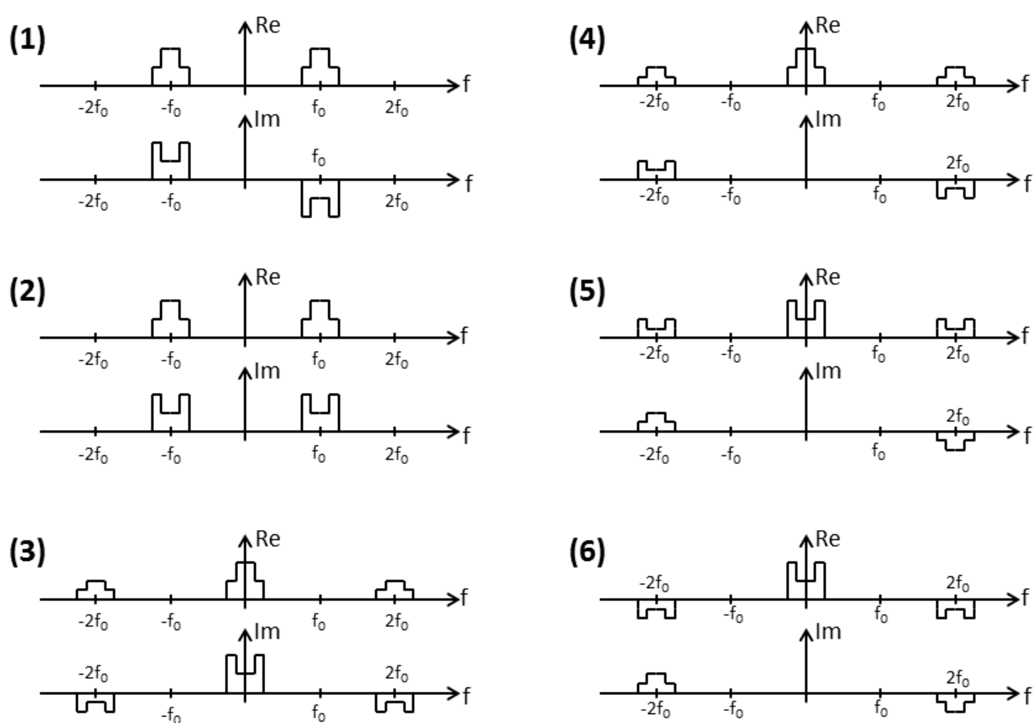
HKUSTx: ELEC1200.2x A System View of Communications: From Signals to...

Consider the following block diagram for an in-phase quadrature communication system. Assume the signal spectra shown on the left hand side correspond to the real parts of the spectra, and that the imaginary parts are zero. Assume that the channel is ideal, so that the signals at the input (transmitter) and output (receiver) are the same.



Which of the signal spectra below correspond to the signals at points A, B and C.



9.2 QUIZ QUESTION 1 (1/1 point)

Which of the spectra corresponds to the signal at point A?

Spectrum 1 ✔ **Answer:** Spectrum 1

EXPLANATION

Since the channel is ideal, the signal at the receiver is the sum of the two modulated carriers (cos and sin). Since m_i modulates $\cos(2\pi f_0 t) = \frac{1}{2}e^{j2\pi f_0 t} + \frac{1}{2}e^{-j2\pi f_0 t}$, there are two copies of its spectrum in the real part of the spectrum at A centered at f_0 and $-f_0$. Since m_q modulates $\sin(2\pi f_0 t) = \frac{1}{2j}e^{j2\pi f_0 t} - \frac{1}{2j}e^{-j2\pi f_0 t} = j\left(-\frac{1}{2}e^{j2\pi f_0 t} + \frac{1}{2}e^{-j2\pi f_0 t}\right)$, there are two copies of its spectrum in the imaginary part of the spectrum at A centered at f_0 and $-f_0$, where the copy at f_0 is flipped in sign.

You have used 1 of 3 submissions

9.2 QUIZ QUESTION 2 (1/1 point)

Which of the spectra corresponds to the signal at point B?

Spectrum 4 ✔ **Answer:** Spectrum 4

EXPLANATION

The signal at B is the signal at A multiplied by $\cos(2\pi f_0 t) = \frac{1}{2}e^{j2\pi f_0 t} + \frac{1}{2}e^{-j2\pi f_0 t}$. Thus, the spectrum at B is the combination of two copies of the spectrum at A centered at f_0 and $-f_0$. Since the components of the imaginary parts of the spectrum of A centered at f_0 and $-f_0$ are the same, only flipped sign, they cancel when they combine at baseband.

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9.2 QUIZ QUESTION 3 (1/1 point)

Which of the spectra corresponds to the signal at point C?

Spectrum 6 ▼ ✔ **Answer:** Spectrum 6

EXPLANATION

The signal at C is the signal at A multiplied by $\sin(2\pi f_0 t) = j\left(-\frac{1}{2}e^{j2\pi f_0 t} + \frac{1}{2}e^{-j2\pi f_0 t}\right)$. Thus, the spectrum at C is the difference of two copies of the spectrum at A centered at $-f_0$ and f_0 multiplied by $j = \sqrt{-1}$. The multiplication by j causes the real and imaginary parts to swap, and since $j \times j = -1$, there is a change in sign when the imaginary part moves to the real part.

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