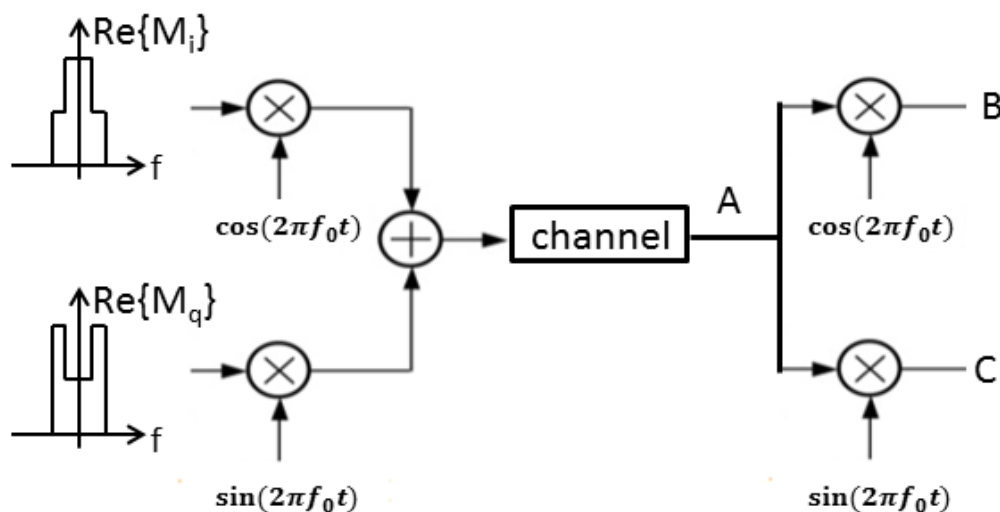


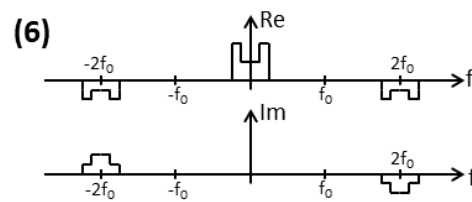
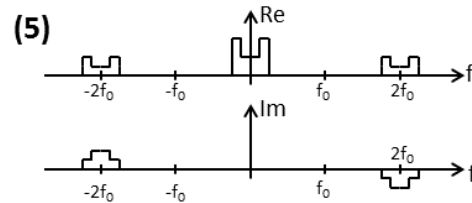
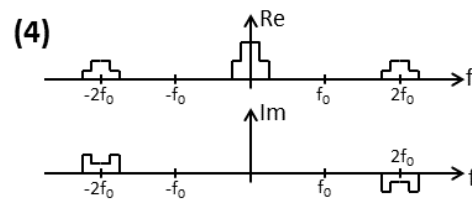
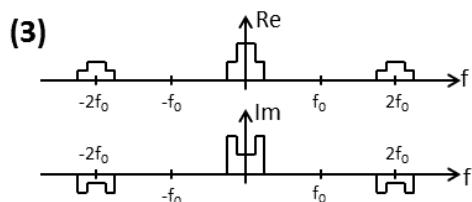
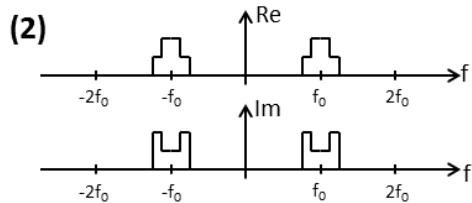
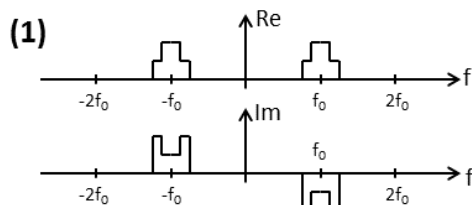


- ▶ Pre-course Materials
- ▶ Topic 1: Course Overview
- ▶ Topic 2: Lossless Source Coding: Hamming Codes
- ▶ Topic 3: The Frequency Domain
- ▶ Topic 4: Lossy Source Coding
- ▶ Topic 5: Filters and the Frequency Response
- ▶ Topic 6: The Discrete Fourier Transform
- ▶ Topic 7: Signal Transmission - Modulation
- ▶ Topic 8: Signal Transmission - Demodulation
- ▼ Topic 9: IQ

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.




## Modulation


### 9.1 Binary Phase Shift Keying

Week 5 Quiz due Nov 30, 2015 at 15:30 UTC 


### 9.2 I/Q Modulation

Week 5 Quiz due Nov 30, 2015 at 15:30 UTC 

### 9.3 Quadrature Phase Shift Keying

Week 5 Quiz due Nov 30, 2015 at 15:30 UTC 

### 9.4 Constellation Diagrams

Week 5 Quiz due Nov 30, 2015 at 15:30 UTC 

### 9.5 Lab 5 - BPSK and QPSK

Lab due Nov 30, 2015 at 15:30 UTC 

- ▶ Topic 10: Summary and Review

- ▶ MATLAB download and tutorials

- ▶ MATLAB Sandbox

## 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.

*You have used 1 of 3 submissions*

## 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.

*You have used 1 of 3 submissions*

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