

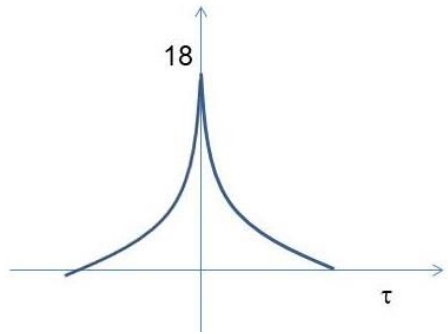
Exercise #1

A message signal $m(t) = \cos 2000\pi t + 2 \cos 4000\pi t$ modulates the carrier $c(t) = 100 \cos 2\pi f_c t$, where $f_c = 1$ MHz.

- (a) Sketch the spectrum of the DSB modulated signal
- (b) Find the complex envelope for the modulated signal

Exercise #2

A stationary random process has an autocorrelation function $R_x(\tau)$ shown in the following figure.



We know that the random process never exceeds 5 in magnitude.

1. How many quantization levels are required to guarantee an SQNR of at least 60 dB ?
2. Assuming that the signal is quantized to satisfy the condition of Part 1 and assuming the approximate bandwidth of the signal is W , what is the minimum required bandwidth for the transmission of a binary PCM signal based on this quantization scheme?

Exercise #3

A signal has a bandwidth of 4kHz. It is sampled, logarithmically compressed and encoded into a PCM format using 8bits per sample. The PCM data is transmitted through an AWGN channel via M-level PAM. Determine the minimum bandwidth required for the transmission when

- (a) $M=4$;
- (b) $M=8$;
- (c) $M=16$

Exercise #4

A bandpass signal is given by

$$x(t) = \text{sinc}(2t) \cos(3\pi t).$$

- (a) Is the signal narrowband or wideband? Justify your answer.
- (b) Find the complex baseband equivalent and sketch carefully its spectrum.
- (a) Give an expression for the Hilbert transform of $x(t)$

Exercise #5

A voice signal in the range 3000 to 3300Hz is sampled at 8000 samples/s. We may transmit these samples directly as PAM pulses or we may first convert each sample to a PCM format and use binary (PCM) waveforms for transmission.

- (a) What is the minimum system bandwidth required for the detection of PAM with no ISI and with a filter roll-off characteristics of $r=1$;
- (b) Using the same roll-off, what is the minimum bandwidth required for the detection of binary (PCM) waveforms if the samples are quantized to eight levels?
- (c) Repeat (b) using 128 quantization levels.