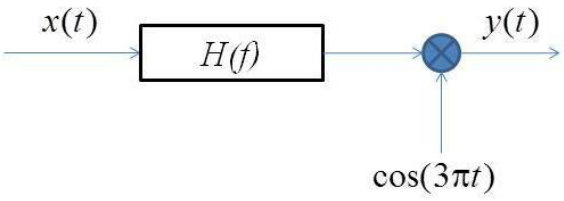
Exam of Digital Communications

a.a. 2015-2016

July 4, 2016

Exercise #1
Let be y(t) the output of the following system,

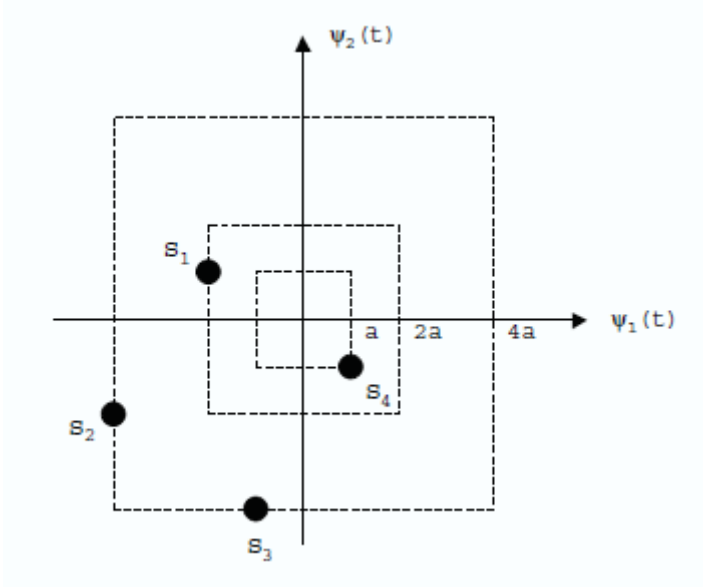


when the input *x(t)=sinc(t)* and *H(f)=(1/2)rect(f/2)*

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

Exercise #2

A digital communication system is designed using bandpass QPSK modulation with Gray mapping. Due to a DC offset and phase error in the modulator, the constellation is translated and rotated as shown in the figure below.



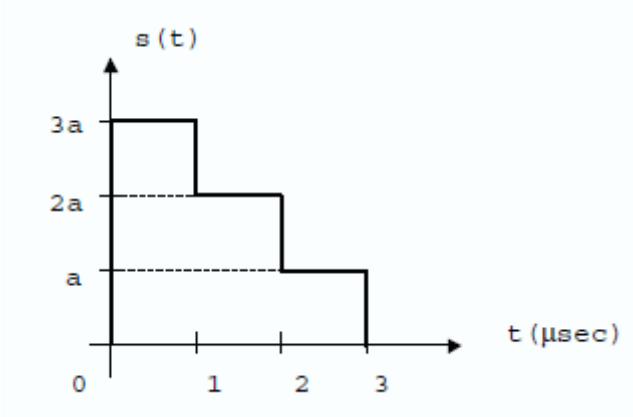
(a) Compute the average energy of the signals and sketch carefully the decision regions.
(b) Find the probability of a bit error *Pb* of this system and compare it with the bit error rate of a conventional QPSK with the same energy per bit Eb (i.e., indicate what is the increase in Eb/N0 that is needed to achieve the same performance in terms of bit error rate).
(c) If a demodulator for conventional QPSK is employed, what is the resulting value of *Pb*?

Exercise #3

A message signal m(t) is transmitted by binary PCM. Let the signal to-quantization noise (SQNR) required be at least 47 dB. Determine the minimum number of bit required to encode each sample, assuming that $m(t)$ is sinusoidal. With this value of quantization levels, determine the SQNR.

Exercise #4

The pulse waveform shown below is used for binary communication with on-off keying.



(a) Determine the value of "a" in terms of average energy per bit Eb
(b) Sketch the impulse response of the filter matched to s(t)
(c) Draw a block diagram of the optimum receiver
(d) What is the bit rate Rb? If we want bit rate Rb of 1Mbps using the same shape of the pulse but with a M-PAM modulation, what is the minimum value of M that is required?
(e) What is the minimum bandwidth that is required for ISI free transmission? Is the bandwidth requirement different in the two considered cases (M-PAM and on-off keying modulation)?

Exercise #5

A new RF technology produces a 5 dB improvement in SNR at the receiver. Discuss how this can be used to enhance performance. Provide some examples.