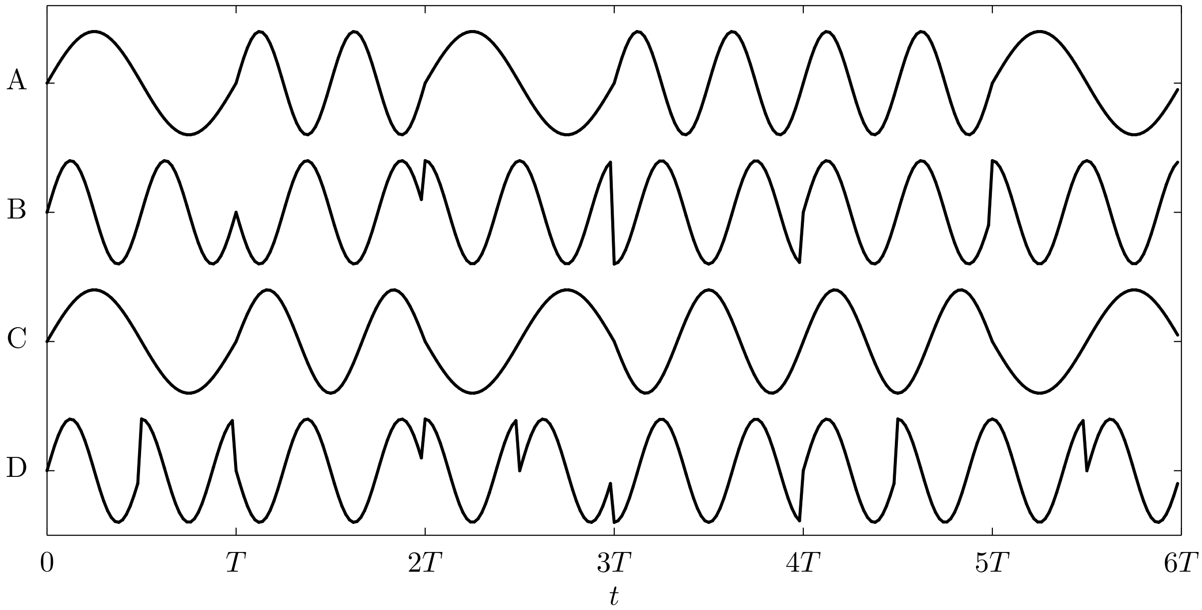
Exercises for chapter 3

1. The following figure represents the signal corresponding to different angle modulations: QPSK, OQPSK, CPFSK y MSK.



   a) For each signal, associate the corresponding modulation and explain the answer.

   b) If the modulation is CPFSK or MSK, obtain de sequence of symbols $I[n] \in \{\pm 1\}$ (assume $I[0] = -1$ in both cases).

2. Answer the following questions related to angular modulations:

   a) Which is the minimum shift among the frequencies of the shaping pulses for the following modulations?

      i) CPFSK modulation (*Continuous Phase Frequency Shift Keying*)

      ii) MSK modulation (*Mimimum Shift Keying*)

   b) How are the 180º phase shifts eliminated for a OQPSK modulation?

   c) A CPM (*Continuous Phase Modulation*) with a modulation index $h = 2$ uses the following pulse

$$g(t) = \begin{cases} A \cdot t, & \text{if } 0 \leq t < T \\ 0, & \text{in any other case} \end{cases}.$$

      i) Get the value of A if the pulse needs to be normalized according to the normalization criteria needed for CPM modulations. Explain if the modulation defined with that pulse is a complete phase CPM or a partial phase CPM.

      ii) For the CPM of previous section get the phase tree for two periods labelling carefully the axes and all the transitions if the information sequence is quaternary $I[n] \in \{\pm 1, \pm 3\}$.

3. Design two modulations based on FSK so that two users can transmit binary information simultaneously without interference and using the smallest bandwidth possible. Give an example of the frequencies that you would use for each user and identify the pulses $g_i(t)$ in each case.

4. A continuos phase modulation (CPM), with modulation index $h = 2$ and a 2-PAM constellation ($I[n] \in \{\pm 1\}$), uses the following normalized pulse

$$g(t) = \begin{cases} A, & 0 \leq t < \dfrac{T}{3} \\ A, & \dfrac{2T}{3} \leq t < T \\ 0, & \text{otherwise} \end{cases}$$

   a) Find the value of A. Then, say if this continuos phase modulation (CPM) is full-response or partial-response CPM, and explain the difference.

   b) Plot the phase tree for 4 symbol periods, properly labelling both axes, and also highlight (on the tree) the phase evolution corresponding to the sequence $I[0] = +1, I[1] = -1, I[2] = -1, I[3] = +1$.

5. Two systems with full-response CPM modulation and modulation index $h = 1$, have the phase trees shown in Figure 1 (note that the phases in the Figure are scaled by the factor π in both cases).

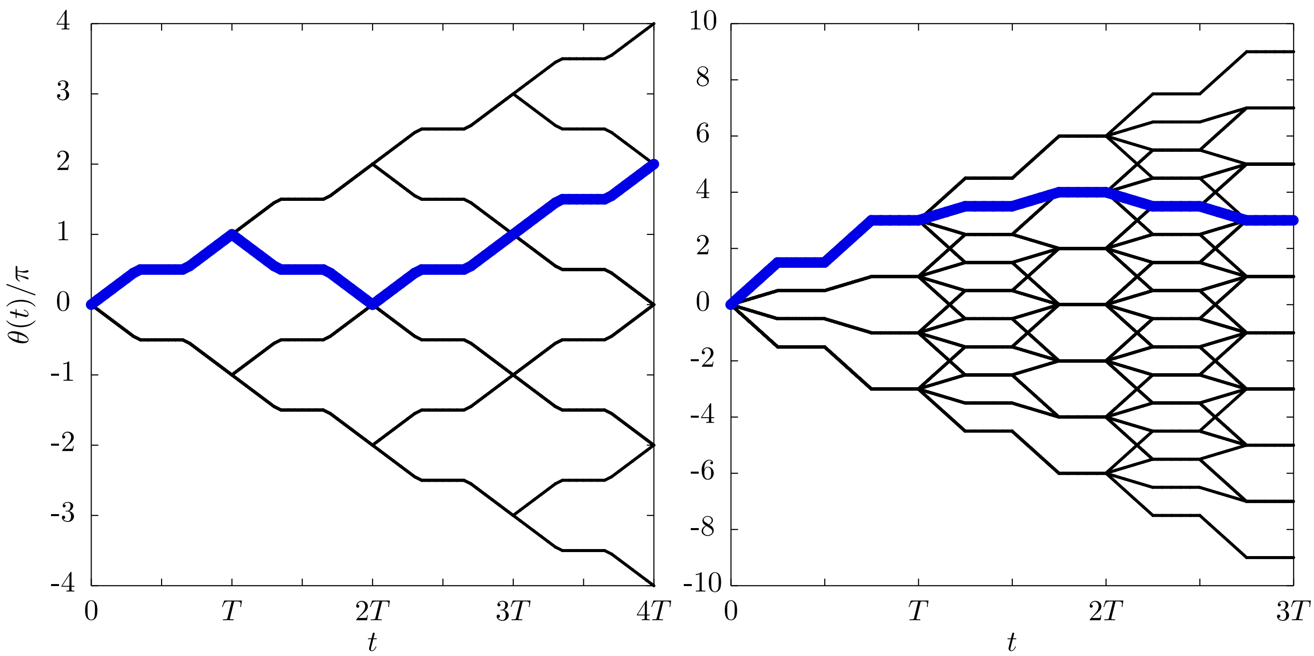


Figure 1: Phase trees for the CPM modulation.

   a) For the first system

      i) Indicate the number of possible values of $I[n]$ (i.e., provide the order of the constellation M), and also provide the M values that $I[n]$ can take.

      ii) Plot, properly labeling both axes, the pulse $g(t)$.

      iii) Obtain the sequence of symbols $I[n]$ corresponding to the path that is highlighted over the tree.

   b) Repeat the previous steps for the second system.

