# Birla Institute of Technology & Science, Pilani, Rajasthan
# First Semester 2022-2023
# Mid-Semester Exam (Close Book)

## EEE G622 Advanced Digital Communications

**Date: 13-03-2023, Duration: 90 Minutes, Maximum Marks:** 25

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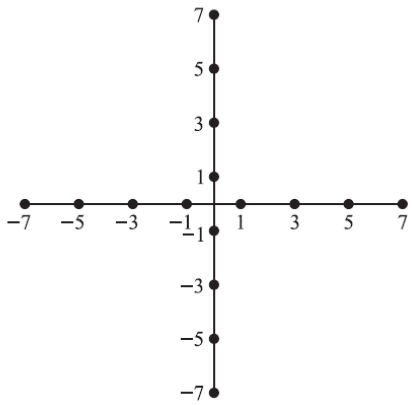
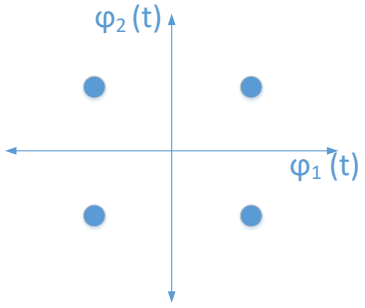
1. Answer the following [**5 Marks**]:
   (a) Illustrate fundamental limits of digital communications for an AWGN band-limited channel considering a channel bandwidth of 200KHz and SNR of 20dB.
   (b) How the continuous phase is maintained in the CPM digital modulation scheme? Illustrate for a modulation scheme using a phase trajectory diagram.
   (c) A random process is given as $X(t) = A\cos(2\pi f_c t + \phi)$ where $A \sim N(\mu, \sigma^2)$ is Gaussian distributed. Here, $\phi$ and $f_c$ are constant. Determine $E[X(t)]$ and ACF $R_x(t_1, t_2)$.

2. A 16-QAM constellation is shown in the figure. Take additive noise as AWGN with $N \sim (0, 1)$ and assume equiprobable symbol transmission. [**5 Marks**]




   (a) Find average symbol energy.
   (b) Draw the decision boundary.
   (c) Find the probability of error only for the symbol "-5" located at the y-axis.
   (d) Find the probability of correctness only for the symbol "1" located at the x-axis.
   (e) Draw another 16-QAM constellation maintain the same minimum distance between adjacent symbols to minimize the average symbol energy.

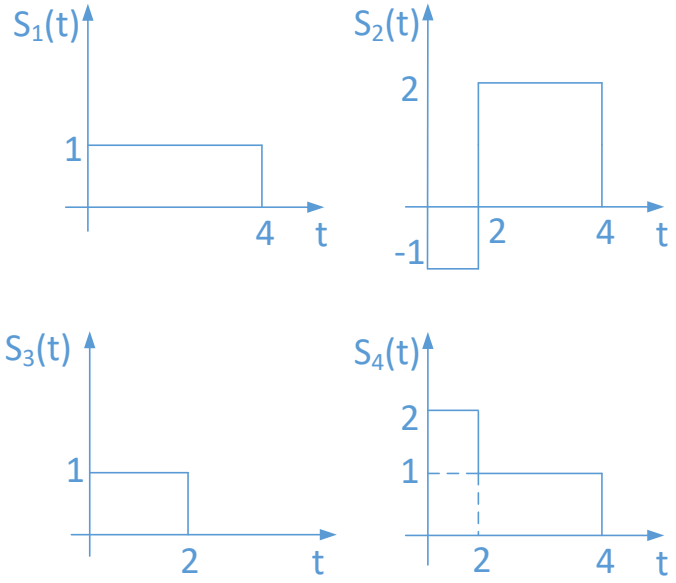
3. A 4-ary constellation is shown in the figure. Assume that the additive noise is distributed as $f_n(n) = \frac{1}{2}e^{-|n|}$ for both in-phase and quadrature-phase. Take the distance between adjacent symbols as $2d$ and equiprobable transmission. [**5 Marks**]




(a) Find the SER.

(b) Find SER if the in-phase noise component (i.e., noise $n_I$) is zero.

4. The four signals $s_1(t)$, $s_2(t)$, $s_3(t)$, and $s_4(t)$ are shown in the figure. [**5 Marks**]




(a) Draw minimum number of basis signals to represent the four signals.

(b) Sketch the vector representation (i.e., constellation diagram) of each signal.

(c) Draw the matched filter corresponding to one of the basis signals.

5. Draw a general transceiver block diagram for an M-ary PSK modulation using signal-space representation applying MAP receiver. Specify the dimension of the signals at the input and output of the system blocks. [**5 Marks**].

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