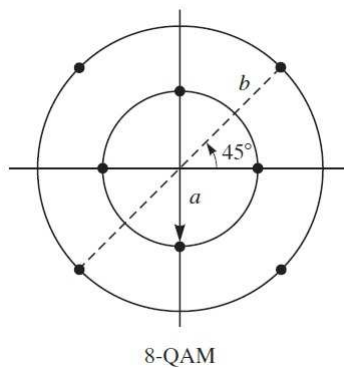# Assignment 3

Digital Communication Systems-I

May 19, 2023

Please answer the following questions. There is only one correct answer.

1. The nearest-neighbour signal points in the 8-QAM signal constellation are separated in distance by A units. Determine the radii a and b of the inner and outer circles, respectively.

8-QAM

   (a) $a = \frac{1}{\sqrt{2}}A$ and $b = \frac{1+\sqrt{3}}{2}A$

   (b) $a = \frac{1}{2}A$ and $b = \frac{1+\sqrt{3}}{2}A$

   (c) $a = \frac{1}{\sqrt{2}}A$ and $b = \frac{1+\sqrt{3}}{2\sqrt{2}}A$

   (d) None of these

2. In the constellation diagram of 8-QAM shown in Question 1, is it possible to assign 3 data bits to each point of the signal constellation such that the nearest (adjacent) points differ in only 1 bit position?

   (a) Yes

   (b) No

   (c) Cannot say

3. For the constellation diagram of 8-QAM shown in Question 1, determine the symbol rate if the desired bit rate is 120Mbits/s.

   (a) 30×10^6 symbols
   (b) 40×10^6 symbols
   (c) 15×10^7 symbols
   (d) 15×10^6 symbols

4. If the average energy for any $M - ary$ PAM is denoted by E_{avg} then find out the minimum distance of the constellation for $M = 8$

   (a) $\sqrt{\frac{4}{15}E_{avg}}$
   (b) $\sqrt{\frac{4}{21}E_{avg}}$
   (c) $\sqrt{\frac{4}{85}E_{avg}}$
   (d) $\sqrt{\frac{8}{255}E_{avg}}$

5. The constellation diagrams for 4-ary QAM, 4-ary PAM and QPSK are all same.

   (a) True
   (b) False

6. In a digital communication system employing binary FSK, the 0 and 1 bit are represented by sine waves of frequencies 10 KHz and 30 KHz respectively. These waveforms will be orthogonal for a bit interval of

   (a) 40μsec
   (b) 125μsec
   (c) 55μsec
   (d) 80μsec

7. Consider a Hadamard matrix H. Then which of the following one is also a Hadamard matrix?

   (a) $\begin{pmatrix} H & -H \\ H & -H \end{pmatrix}$
   (b) $\begin{pmatrix} H & -H \\ -H & H \end{pmatrix}$
   (c) $\begin{pmatrix} -H & H \\ H & -H \end{pmatrix}$
   (d) $\begin{pmatrix} H & H \\ H & -H \end{pmatrix}$

8. The vector representation for signals are given by $s_1 = (\sqrt{\varepsilon}, 0)$, $s_2 = (0, \sqrt{\varepsilon})$, $s_3 = (\sqrt{\varepsilon}, \sqrt{\varepsilon})$, $s_4 = (-\sqrt{\varepsilon}, \sqrt{\varepsilon})$. Which of the following is a correct statement for these signals?

   (a) They are orthogonal signals

   (b) They are bi-orthogonal signals

   (c) They are simplex signals

   (d) None of the above

9. Assume a simplex signalling with M orthogonal waveforms. What is the cross-correlation of any pair of signals with $M = 8$?

   (a) $\frac{1}{7}$

   (b) $\frac{-1}{7}$

   (c) $\frac{1}{15}$

   (d) $\frac{-1}{15}$

10. For any $M - ary$ PSK, if the minimum distance between two closest pair of signal is $\sqrt{E_{avg}}$ (E_{avg} is the average energy of the signal) then find out the value of M.

   (a) 2

   (b) 4

   (c) 8

   (d) 16