Assignment 2
(Topic 3. Design of Sequences with Low Correlation)

1. Let $\mathbf{a} = (111101100101000)$ be a binary sequence of period 15.

   (a) Determine if the sequence satisfies the Golomb randomness postulates R-1 and R-2.

   (b) Compute the autocorrelation function $C(\tau)$ for $\tau = 0, 1, \cdots, 6$.

   (c) Is the sequence an m-sequence? Why?

2. Determine the Legendre sequence modulo 17. Verify whether it has the balance property R-1 and the run property R-2, and compute the autocorrelation function $C(\tau)$, for $\tau = 0, 1, \cdots, 16$.

3. Compute the autocorrelation function of the Legendre sequence of period 31, $C(\tau)$, where $\tau = 0, 1, 3, 5, 7, 11, 15$.

4. Construct a binary sequence of period 15 which is constant-on-cosets, but does not have the two-level correlation property R-3.

5. Verify that the following binary sequence of period 127 has the run property and that $C(9) = 3$.

   ```
   1 1 1 1 1 1 1 0 1 1 1 1 1 1 0 0 1 1 1 1 1 0
   1 0 1 1 1 0 0 0 0 1 1 0 1 1 1 0 1 0 0 1
   1 0 0 0 1 0 1 0 1 1 0 0 0 0 0 1 0 1 1 1
   1 0 0 0 1 1 1 0 1 1 0 1 1 0 0 1 0 0 1 0
   1 0 0 1 0 0 0 0 1 0 0 1 1 1 0 0 1 0 1 1
   0 1 0 0 0 1 0 0 0 1 1 0 0 1 1 0 1 0 1 0
   1 0 0 0 0 0 0
   ```

   Hence it does not have the two-level correlation property R-3. (Note: This sequence is constructed from an m-sequence of period 127, generated by the primitive polynomial $f(x) = x^7+x+1$, by complementing all bits in the m-sequence except for the first bit. In other words, if we complement all bits of the above sequence except for the first bit, then the resulting sequence is an m-sequence generated by $f(x)$. This comes from a general construction for binary sequences which have the run property, but violate the 2-level autocorrelation property. See reference [**?**]). Verify whether this sequence is constant-on-cosets.

6. There are 50 users in an indoor wireless mobile communication network system. The system requires that

   (a) the scrambling sequence (binary) used by each user is shift distinct from the other users;

   (b) each sequence is balanced with length 127;

   (c) the maximal crosscorrelation between any two of these sequence is 17.

   Design a signal set which satisfies these requirements.

7. Design a Kasami set with parameters (63, 8, 9) by using a different design from the example shown in the text.

(a) Give the LFSR implementation.

(b) How many shift sequences are in this Kasami set?

(c) Compute the 0-1 distribution for each signal in the Kasami set and cross correlation for one pair of the signals.

8. A CDMA system needs to employ a signal set with a period of at least 1024, and the maximal value of the crosscorrelation of the signal set is less than 80. How many such designs are there? Give the parameters for each of these design.