Sirindhorn International Institute of Technology

Thammasat University at Rangsit

School of Information, Computer and Communication Technology

ECS 455: Problem Set 5

Semester/Year: **2/2016**

Course Title: Mobile Communications
Instructor: Asst. Prof. Dr. Prapun Suksompong (prapun@siit.tu.ac.th)
Course Web Site: http://www2.siit.tu.ac.th/prapun/ecs455/

Due date: April 28, 2017 (Friday), 4:30 PM

Instructions

1. (1 pt) Write your first name and the last three digits of your student ID on the upper-right corner of every submitted sheet.
2. (1 pt) For each part, write your explanation/derivation and answer in the space provided.
3. (8 pt) It is important that you try to solve all non-optional problems.
4. Late submission will be heavily penalized.

Questions

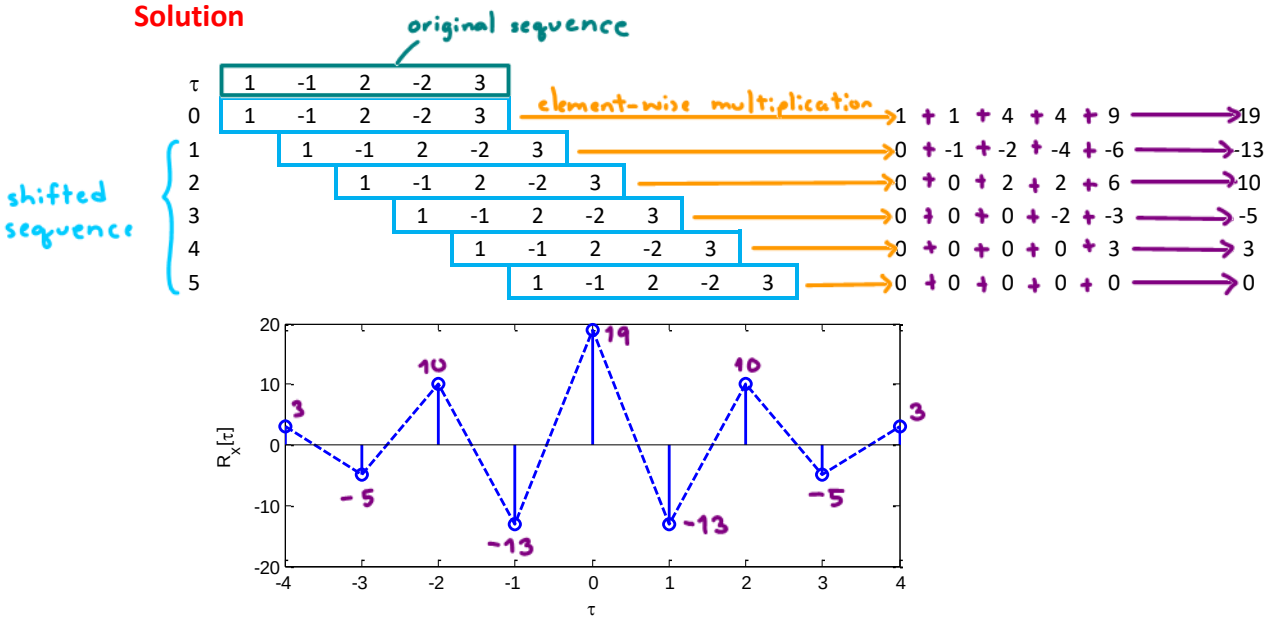
1. Consider Global System for Mobile (GSM), which is a TDMA/FDD system that uses 25 MHz for the forward link, which is broken into radio channels of 200 kHz. If 8 speech channels are supported on a single radio channel, and if no guard band is assumed, find the number of simultaneous users that can be accommodated in GSM.

Solution

$$\frac{25\times10^{6}}{200\times10^{3}}\times 8 = 1000 \text{ simultaneous users.}$$

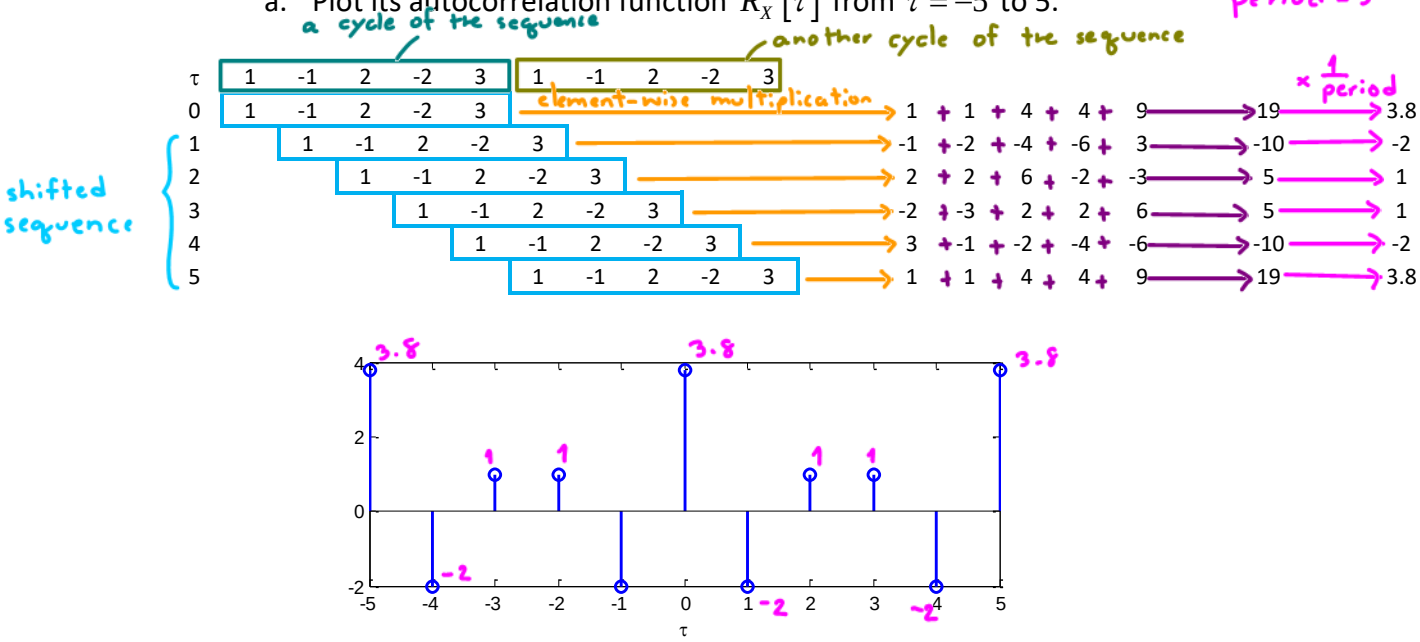
2. Consider a sequence *x*[n] = (1 -1 2 -2 3). Plot its autocorrelation function $R_X[\tau]$ from $\tau = -4$ to 4.

Solution



3. Consider a periodic sequence *x*[n]. Each complete cycle of it is a sequence (1 -1 2 -2 3).

   a. Plot its autocorrelation function $R_X[\tau]$ from $\tau = -5$ to 5.

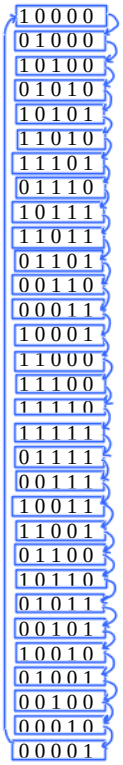
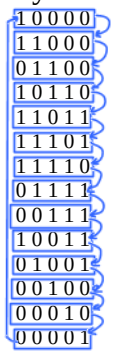
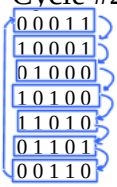
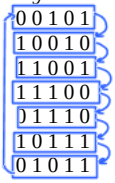
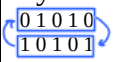
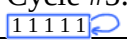
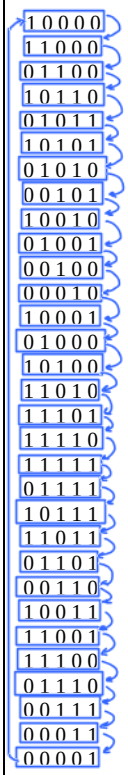


   b. Is $R_X[\tau]$ periodic? If so, find the period of $R_X[\tau]$.

Yes. Its period is 5. (Same as period as the sequence.)

4. Draw the complete state diagrams for linear feedback shift registers (LFSRs) using the following polynomials. Does either LFSR generate an m-sequence?
   a. $1+x^2+x^5$
   b. $1+x+x^2+x^5$
   c. $1+x+x^2+x^4+x^5$

Solution

(a) $1+x^2+x^5$	(b) $1+x+x^2+x^5$	(c) $1+x+x^2+x^4+x^5$
(a) The LFSR will cycle through the following sequence of states: 	(b) The LFSR will cycle through one of the cycles of states below. The initial state determine which cycle it will go through. Cycle #1:  Cycle #2:  Cycle #3:  Cycle #4:  Cycle #5: 	(c) The LFSR will cycle through the following states: 

The polynomial $1+x^2+x^5$ and $1+x+x^2+x^4+x^5$ from part (a) and (c) generate m-sequences. (Their states go thorough cycle of size 2^5-1)

5. Use any resource, find <u>all</u> primitive polynomials of degree 6 over GF(2). Indicate your reference.

Solution

Primitive Polynomials
$x^6 + x^1 + 1$
$x^6 + x^5 + x^2 + x^1 + 1$
$x^6 + x^5 + x^3 + x^2 + 1$
$x^6 + x^4 + x^3 + x^1 + 1$
$x^6 + x^5 + x^4 + x^1 + 1$
$x^6 + x^5 + 1$

Source: http://www.theory.cs.uvic.ca/~cos/gen/poly.html