ITCS-424
Sem 2- 2019
Homework 2: Spread Spectrum
29/2/20
Time Limit: Minutes

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This homework contains 6 pages (including this cover page) and 4 problems. Check to see if any pages are missing. Enter all requested information on the top of this page, and put your initials on the top of every page, in case the pages become separated.

You may *not* use your books, notes, but scientific calculator on this exam.

You are required to show your work on each problem on this exam. The following rules apply:

- **If you use a "fundamental theorem" you must indicate this** and explain why the theorem may be applied.
- **Organize your work**, in a reasonably neat and coherent way, in the space provided. Work scattered all over the page without a clear ordering will receive very little credit.
- **Mysterious or unsupported answers will not receive full credit**. A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.
- If you need more space, use the back of the pages; clearly indicate when you have done this.

Do not write in the table to the right.

Problem	Points	Score
1	4	
2	6	
3	4	
4	2	
Total:	16	

1. Fundamental for Spread Spectrum Communication.

   (a) (1 point) Define a Channel Capacity formula.

   Solution: $C = B \cdot \log_2(1+SNR)$

   (b) (1 point) Suppose SNR of Bluetooth wireless channel is 15 dB, what is maximum capacity of the channel.

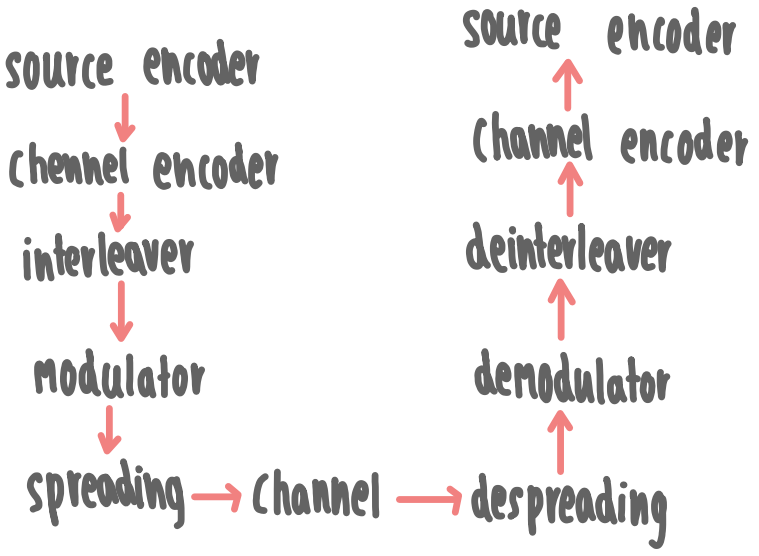
   Solution: $10\log(SNR) = 15$ $\quad C = B \cdot \log_2(1+31.62)$
   $SNR = 31.62$ $\quad C = 5.02\ B$

   (c) (1 point) Suppose SNR of Bluetooth channel decrease from 15 dB to 10 dB, what is the strategic to compensate from SNR for the same channel capacity¿

   Solution: Compensate by increasing the BW by $\frac{\log_2(1+31.62)}{\log_2(1+10)} = 1.45$ times

   (d) (1 point) Draw diagram of coventional vs spread spectrum communication.

   Solution:



2. FHSS in Bluetooth

(a) (1 point) How FHSS combat interference?

Solution: FHSS signals are highly resistant to narrowband interference because the signal hops to a different frequency band. Signals are difficult to intercept if the frequency hopping pattern is not know.

(b) (1 point) In bluetooth, one time slot is 625 microsecond.
How many time slots for communication in one second?

Solution: $\frac{1 \text{ sec}}{625 \times 10^{-6} \frac{1}{\text{sec}}} = 1,600$ time slots

(c) (1 point) In bluetooth, if there are only one master node and slave node then how many time slave changes channel frequency in one second?

Solution: - master node change every even slot
- slave node change every odd slot
$: \frac{1600}{2} : 800$ times

(d) (1 point) What is processing gain in spread spectrum?

Solution: Process gain is the ratio of the spread (or RF) bandwidth to the unspread (or baseband) bandwidth.

(e) (1 point) In blue tooth, 1MHz channel is spreaded to 80MHz,
what is the processing gain in dB?

Solution: $10 \log\left(\frac{80 \text{ MHz}}{1 \text{ MHz}}\right) = 19.03$ dB

(f) (1 point) Using previous information from items in FHSS questions,
what is the jamming majin assumed internal system loss is 3dB?

Solution: $Mj = G - L = 19.03 - 3 = 16.03$ dB

3. (4 points) DSSS

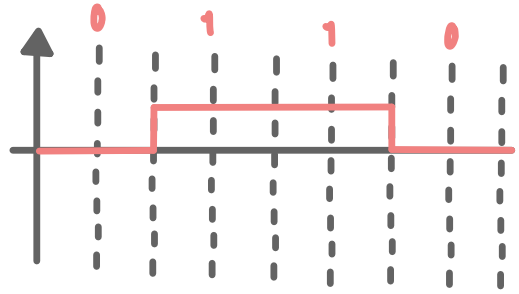
Given the input data sequence is 0110,
Carrier frequency = 400 MHz, Chip rate = 200 Mbps,
Symbol rate = 100 M symbol per second
Suppose we use BPSK modulation ($let 0 = 0\,\text{deg}, 1 = 180\,\text{deg}$)
Spreading sequence (PN) is periodic of the following sequence 10
Draw the output waveform of the DSSS modulation carrier for this input data sequence.

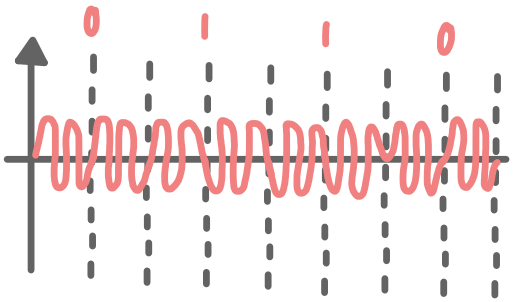
Solution:

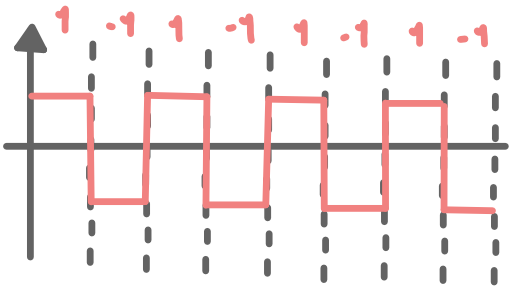
Cycle / symbol : 400/100 : 4

Cycle / chip : 400/200 : 2

Spreadding factor : 4/2 : 2







4. CDMA Suppose we have four stations; each has a sequence of chips which we designate as A, B, C, D.

   (a) (1 point) Gernates walsh table for W_{4N} if

$$W_N = [-1]$$

Solution:

$W_1 : [-1]$

$W_2 : \begin{bmatrix} -1 & -1 \\ -1 & -1 \end{bmatrix}$

$W_4 : \begin{bmatrix} -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 \end{bmatrix}$

   (b) (1 point) From previous walsh table, if the sending signal is

$$S = -A - B + D$$

show how to decode data for all station.(Hint: inner product)

Solution:

$A : -1 \cdot (-1,-1,-1,-1) : (1,1,1,1)$

$B : -1 \cdot (-1,1,-1,1) : (1,-1,1,-1)$

$C : 0 \cdot (-1,-1,1,1) : (0,0,0,0)$

$D : 1 \cdot (-1,1,1,-1) : (-1,1,1,-1)$

$\rightarrow (1,1,3,-1)$

$S \cdot A : (1,1,3,-1) \cdot (-1,-1,-1,-1) : -4 \; ; -4/4 : -1$

$S \cdot B : (1,1,3,-1) \cdot (-1,1,-1,1) : -4 \; ; -4/4 : -1$

$S \cdot C : (1,1,3,-1) \cdot (-1,-1,1,1) : 0 \; ; 0/4 : \text{silent}$

$S \cdot D : (1,1,3,-1) \cdot (-1,1,1,-1) : 4 \; ; 4/4 : 1$