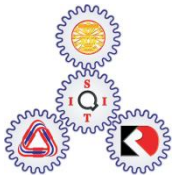

Sirindhorn International Institute of Technology

Thammasat University at Rangsit

School of Information, Computer and Communication Technology

ECS 455: Problem Set 7

Semester/Year: **2/2016**

Course Title: Mobile Communications
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Course Web Site: http://www2.siit.tu.ac.th/prapun/ecs455/

Due date: Not Due

Questions

1. Select the terms (provided at the end of the problem) to complete the following description of OFDM systems:

   Wireless systems suffer from _____ problem. An important technique that works well in wireless systems is OFDM. The general idea is to _____ the symbol or bit time so that it is _____ compared with the channel delay spread. To do this, we separate the original data stream into multiple parallel substreams and transmit the substreams via different carrier frequencies, creating parallel subchannels. This is called _____. In such direct implementation, there are two new problems to solve: bandwidth inefficiency and complexity of the transceivers. The inefficient use of bandwidth is caused by the need of _____ between adjacent subchannels. Bandwidth efficiency can be improved by utilizing _____. The computational complexity of the transceivers is solved by the use of _____.

   Here are the terms to use. Some term(s) is/are not used.

   - FFT and IFFT
   - FDM
   - multipath fading
   - local oscillators
   - guard bands
   - guard times
   - reduce
   - increase
   - small
   - large
   - spectral efficiency
   - orthogonality

2. In this question, we will consider an OFDM system in discrete time. The channel is characterized by $\mathbf{h} = \begin{bmatrix} 2 & -1 \end{bmatrix}$. We would like to transmit a stream $\begin{bmatrix} 1 & -1 & 2 & 1 & -1 & 2 & 1 & 2 \end{bmatrix}$ of data across this channel using OFDM. For simplicity, we will assume that there is no noise. Let *N* = 4 be the length of each OFDM symbol.
    a. Find the transmitted vector **x**. (Apply IFFT with scaling by $\sqrt{N}$. Then add cyclic prefix.) To reduce the overhead, the cyclic prefix should be as short as possible.
    b. The received vector is $\mathbf{y} = \mathbf{x} * \mathbf{h}$. (Note that this is a regular convolution.) Find $\mathbf{y}$.
    c. Find $\mathbf{H}$ which is the FFT of the zero-padded $\mathbf{h}$.
    d. Remove the "irrelevant parts" from $\mathbf{y}$. Then apply FFT with scaling by $1/\sqrt{N}$. Finally, use the corresponding property in frequency domain of the circular convolution (in time) for DFT to recover the original data from $\mathbf{y}$.