Problem Set 3  
Assigned: Thursday, Feb. 3, 2005  
Due: Thursday, Feb. 10, 2005

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**Sampling & Fourier Transform**

3.1: Proakis and Manolakis 1.5  
3.2: Proakis and Manolakis 1.11  
3.3: Proakis and Manolakis 1.15  
3.4: Proakis and Manolakis 4.9  
3.5: Proakis and Manolakis 4.10  
3.6: Proakis and Manolakis 4.17

**Lab Assignment 3: Sampling**

L3.1: The goal of this lab assignment is to illustrate the Fourier domain relationships of the several sampling rate conversions defined in Proakis and Manolakis 4.23 (page 374). Let $x[n]$ and $X(e^{j\omega})$ represent a sequence and its Fourier transform, respectively. Suppose $X(e^{j\omega})$ is given as follows:

$$X(e^{j\omega}) = \begin{cases} 
1 - \frac{|\omega|}{\pi}, & \text{if } |\omega| \leq \frac{\pi}{4}, \\
0, & \text{otherwise},
\end{cases}$$

with the $2\pi$ periodicity of $X(e^{j\omega})$ understood. We first use the following Matlab script to generate a length-256 sequence $X[n]$, which we assume is the sampled version of $X(e^{j\omega})$, with $X[n] = X(e^{j\frac{2\pi(n-1)}{256}})$, for $1 \leq n \leq 256$.

```matlab
for i=1:32
    X(i)=1-(i-1)/32;
end
for i=33:224
    X(i)=0;
end
for i=225:256
    X(i)=(i-225)/32;
end
```

We then take the inverse Fourier transform of $X[n]$ to get the time-domain sequence $x[n]$ by using `x=ifft(X,256)` in Matlab. You are required to use Matlab to plot the Fourier transform of the sampler sequence $y_1[n]$, (b) the compressor sequence $y_2[n]$, and (c) the expander sequence $y_3[n]$.

Check your experimental results with the following formula:

(a) $Y_1(e^{j\omega}) = \frac{1}{2}X(e^{j\omega}) + \frac{1}{2}X(e^{j(\omega+\pi)})$,

(b) $Y_2(e^{j\omega}) = \frac{1}{2}X(e^{j\frac{\omega}{2}}) + \frac{1}{2}X(e^{j(\frac{\omega}{2}+\pi)})$,

(c) $Y_3(e^{j\omega}) = X(e^{2j\omega})$. 

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