EECE695f Fall 2005

HW#9

1. Consider a linearly modulated signal in complex baseband given by

$$x(t) = \sum_{n=-\infty}^{\infty} d[\lfloor \frac{n}{N} \rfloor] \, a[n] \, p(t - nT_c)$$

where $\lfloor \cdot \rfloor$ denotes the flooring function. Throughout this problem, assume $\{d[m]\}_{m=-\infty}^{\infty}$ is a sequence of i.i.d. proper-complex random variables with unit variance / zero-mean

Answer the following questions.

(a) Show that

$$b[n] \triangleq d[\lfloor \frac{n}{N} \rfloor] \, a[n]$$

is a sequence of uncorrelated zero-mean proper-complex random variables with unit variance if $a[n]$ is a sequence of uncorrelated zero-mean proper-complex random variables with unit variance

(b) In (a), plot the PSD of $\mathrm{Re}\{x(t) e^{j2\pi f_c t}\}$ when $p(t)$ is the SRRC w/ $\beta = 1$ and $f_c = \frac{4}{T_c}$.

2. Suppose that in Problem 1,

$$a[n] = c[n \bmod N] \quad \forall n$$

and $N = 8$, $T_c = 1$, $p(t)$ is the SRRC w/ $\beta = 1$.

Answer the following questions.

(a) When $c[n]=1$, $\forall n$, plot the PSD of $x(t)$ using MATLAB.

(b) When $\underline{c} \triangleq \begin{bmatrix} c[0] \\ c[1] \\ \vdots \\ c[7] \end{bmatrix} = \begin{bmatrix} e^{j\frac{2\pi\cdot 0}{8}} \\ e^{j\frac{2\pi\cdot 1}{8}} \\ \vdots \\ e^{j\frac{2\pi\cdot 7}{8}} \end{bmatrix}$, plot the PSD of $x(t)$ using MATLAB

(c) When $\underline{c} = \begin{bmatrix} e^{j\frac{2\pi\cdot 40}{8}} \\ e^{j\frac{2\pi\cdot 41}{8}} \\ \vdots \\ e^{j\frac{2\pi\cdot 47}{8}} \end{bmatrix}$, plot the PSD of $x(t)$ using MATLAB

(d) When $\underline{c} = \begin{bmatrix} 1 \\ 1 \\ -1 \\ 1 \\ 1 \\ -1 \\ -1 \end{bmatrix}$, plot the PSD of $x(t)$ using MATLAB.

(e) When $\underline{c} = \begin{bmatrix} e^{j\frac{2\pi\cdot 0}{5}} \\ e^{j\frac{2\pi\cdot 1}{5}} \\ e^{j\frac{2\pi\cdot 5}{5}} \\ e^{j\frac{2\pi\cdot 6}{5}} \\ e^{j\frac{2\pi\cdot 7}{5}} \end{bmatrix}$, plot the PSD of $x(t)$ using MATLAB.

(f) When $\underline{c} = \begin{bmatrix} e^{j0} \\ e^{j\frac{\pi}{4}} \\ e^{j\frac{2\pi}{4}} \\ e^{j\frac{3\pi}{4}} \\ e^{j\frac{4\pi}{4}} \\ e^{j\frac{5\pi}{4}} \\ e^{j\frac{6\pi}{4}} \\ e^{j\frac{7\pi}{4}} \end{bmatrix}$, plot the PSD of $x(t)$ using MATLAB