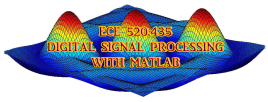
Johns Hopkins University Lecturer: Hassan Mohy-ud-Din



ECE 520.435 Digital Signal Processing with MATLAB

September 21, 2011 http://dsp435.wordpress.com

Problem Set 1

Problem 1: Let the sequence $y[n] = [1\ 2\ 3\ 4\ 5\ 6]$ with indices $[2:1:7]$. Graph the following sequences over the range $n = -10:1:10$ on the same plot.

1. $y[n-1]$
2. $y[n+2]$
3. $y[1-n]$
4. $y[-3-n]$

Problem 2: Given a discrete-time signal $x[n] = \{0\ 0\ 1\ \underline{1}\ 1\ 1\ \frac{1}{2}\ \frac{1}{2}\}$. Generate and stem the following signals (use *subplots*):

1. $x[n-2]$
2. $x[4-n]$
3. $x[n]u[2-n]$
4. $x[-2-n]$
5. $x[n-1]\delta[n-3]$
6. $x[n^2]$
7. $x[3n]$
8. $x[\frac{n}{4}]$

Note: Underline in $x[n]$ means the sample is at $n = 0$

Problem 3: Write MATLAB scripts which compute linear combinations of unit-step, impulse and ramp functions. Name the function **UnitStep(coeff,index,flip)**, **ImpulseFunc(coeff,index,flip)** and **RampFunc(coeff,index,flip)**. Linear combination means $a_1x[n-k] + a_2x[n-j]$. Generate in MATLAB using these functions:

1. $rect[\frac{n}{k}] = u[n+\frac{k}{2}] - u[n-\frac{k}{2}]$
2. $u[n] = \sum_{k=1}^{n} \delta[n-k]$

3. *5*-cycles of Sawtooth Waveform (*Hint: Use the* ***RampFunc()*** *and* ***repmat()***)

4. *5*-cycles of Square Waveform (*Hint: Use the rect() from part (1) and* ***repmat()***)

5. $sgn(n) = \begin{cases} -1 & : n < 0 \\ 0 & : n = 0 \\ 1 & : n > 0 \end{cases}$. This is known as the *signum* function. (*Hint: Use the* ***UnitStep()***)

Problem 4: Use MATLAB to generate the following signals if **x[n]=u[n]-u[n-1]** for $0 \leq n \leq 5$:

1. $x[-n]$
2. $x[n+2]$
3. $x[n] + x[-n]$
4. $x[n-2] + x[n+2]$
5. $x[-n-1].x[n]$
6. $x[-n].x[n] + x[-n-1]$
7. $x[n] + cos(2\pi n + \pi)$
8. $x[-n] + cos(3\pi n + \frac{\pi}{2})$
9. $(0.1)^n x[n] + cos(3\pi n + \frac{\pi}{2})$

Problem 5: Use MATLAB to sketch the even and odd parts of the following signals. Repeat it for the decomposition centered around $n = 0$:

1. $x[n] = u[n] - u[n-1]$; $0 \leq n \leq 5$
2. $x[n] = nu[n]$; $0 \leq n \leq 5$
3. $x[n] = (0.1)^n cos(2\pi n + 1)$; $0 \leq n \leq 5$
4. $y = cos(2\pi(0:1:16)/16)$

Problem 6: Generate the following signals in MATLAB

1. $x[n] = \{\ldots\ 5\ 4\ 3\ 2\ 1\ \underline{5}\ 4\ 3\ 2\ 1\ 5\ 4\ 3\ 2\ 1\ \ldots\}$; $-10 \leq n \leq 9$
2. Let $x[n] = \{1\ -2\ 4\ 6\ \underline{-5}\ 8\ 10\}$. Stem the signal $y[n] = \sum_{k=1}^{5} nx[n-k]$

Problem 7: Find the following signals if $x[n] = nu[n-1]$, $-\infty < n < \infty$.

1. $x[2n]$

2. $x[\frac{n}{3}] + x[-n]$
3. $x[-n]u[n-2] + \delta[n]$
4. $u[\frac{n}{2}] - x[n]$
5. $x[-n-2] + u[n-2]$

Problem 8: Verify the periodicity of the following signals for $n > 0$ and compute its period graphically.

1. $cos[2\pi n + \pi]$
2. $u[n] + 1$
3. $\delta[n] + u[n]$
4. $cos[\sqrt{2}\pi n]$
5. $u[n] + cos[2\pi n + \pi]$
6. $cos[2\pi n + \pi] + \delta[n-1]$
7. $cos[\frac{3}{2}n + \pi] + u[n]$

Problem 9: Consider the following signals:

1. $x(t) = e^{-3t}u(t)$
2. $x(t) = e^{-t}cos(1000t)u(t)$

Take samples from both signals every $2sec$. Plot $x[n]$ for both.

Appendix

Writing functions in MATLAB is a very simple process. See the following steps:

1. On the command window of MATLAB (next to the command prompt) type:
   >> **edit file_name**
   Filename could be any name except one which is also a built-in function e.g. plot, sin, log etc. You can easily verify by typing the following command.
   >> **help file_name**
2. A new window will open, called the edit window. Write the following line at the start of the edit window:
   function [output_1,output_2,output_3] = file_name(input_1,input_2,input_3)
   Save the file with the same name as the function name. Type the code, also called the function body, after the afore-mentioned function definition.

3. Terminate the function body by typing at the last line:
   end

Best of luck with the assignment