

EE432 Fall 2010 Homework Problem Set 1 (PS01)

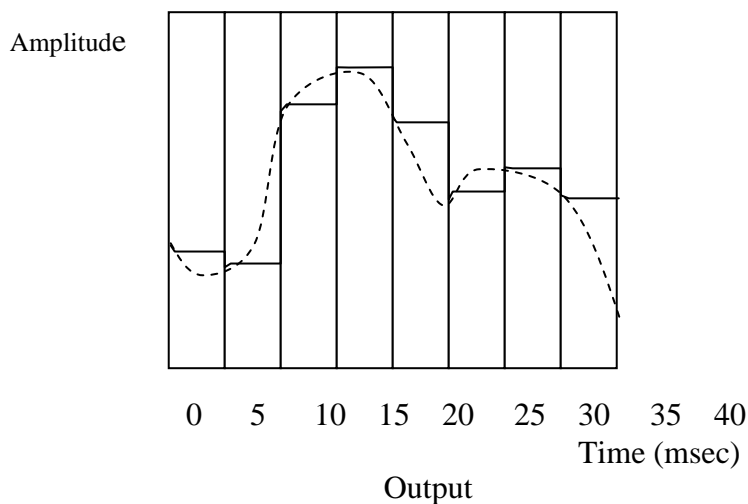
Due: 03 Sep 2010

Turn in your code and copy/paste the results from the MATLAB command window.

1. Text, problem 1.3.
 - (a) **sound**
 - (b) **light**
 - (c) **temperature**
 - (d) **light**
 - (e) **acceleration**
 - (f) **light**
 - (g) **temperature**
-

2. Text, problem 1.4.

During the acquisition time of the sampler, the output of the sample and hold circuit follows the input signal. For the remainder of the cycle, the output remains steady. The acquisition time accounts for 1/20 of each sampling period.



3. Text, problem 2.4.

$\omega = 4000$ rad/sec, so $f = 4000/(2\pi) = 2000/\pi$ Hz, and $T = \pi/2000$ sec. Therefore, five periods cover $5\pi/2000 = \pi/400$ sec. For this signal, the Nyquist sampling rate is $2(2000/\pi) = 4000/\pi$ Hz, so the sampling rate in this case is $f_s = 4(4000/\pi) = 16000/\pi$ Hz. Therefore, the total number of samples collected in five periods is $(16000/\pi \text{ samples/sec})(\pi/400 \text{ sec}) = \mathbf{40}$.

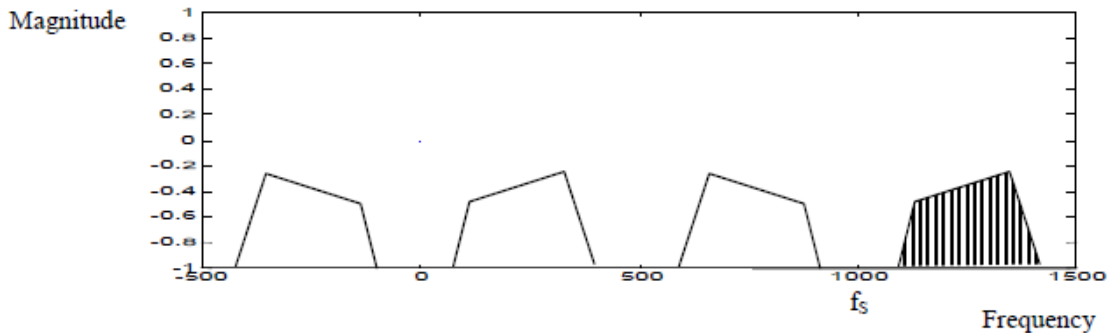
4. Text, problem 2.5.

$\omega = 2500\pi$ rad/sec, so $f = 2500\pi/(2\pi) = 1250$ Hz, and $T = 1/1250$ sec. Therefore, five periods cover $5/1250$ sec. For this signal, the Nyquist sampling rate is $2(1250) = 2500$ Hz, so the sampling rate in this case is $f_s = 7/8(2500) = 2187.5$ Hz. The total number of samples collected is

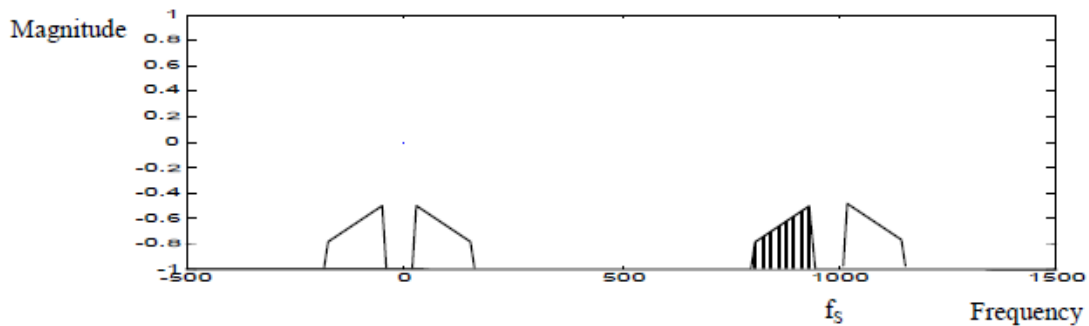
$(2187.5 \text{ samples/sec})(5/1250 \text{ sec}) = 8.75.$

This means only 8 samples are collected while five periods of the analog signal elapse.

5. Text, problem 2.10. Baseband = Nyquist Range = $[0, f_s/2]$
 (a) The signal **aliases to the range 100 to 400 Hz. Spectral inversion does NOT occur in the baseband.**



- (b) The band-limited signal **aliases to the range 50 to 200 Hz. Spectral inversion occurs in the baseband.**



6. Text, problem 2.19.

The quantization errors are calculated by subtracting the true signal value from the quantized value. The absolute value of these numbers is an okay answer, because you're just asked how much error there is.

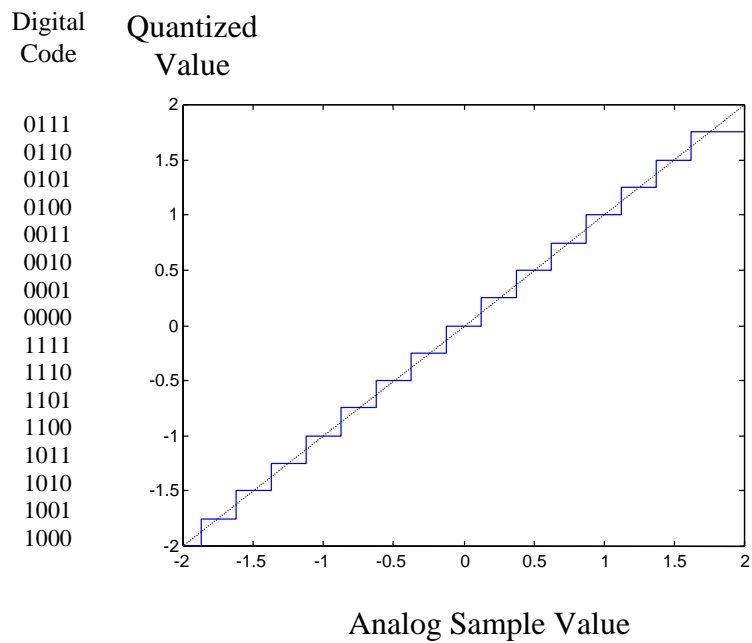
n	0	1	2	3	4	5	6	7	8	9
Quantization Error	-0.4	0.3	-0.1	0.4	-0.3	-0.1	0.4	-0.1	-0.2	-0.2

7. Text, problem 2.20.

Quantization Step = $\text{Range}/2^N = (2 - (-2))/2^4 = 0.25 \text{ V}$

The table below describes the quantization method. The bottom range is half a step wide, while the top range is one and a half steps wide. All other ranges are one quantization step wide. The quantization diagram is provided as well. Note: this is NOT the best way to do this.

Digital Code	Decimal value of digital code	Quantized Level (V)	Range of Analog Input Mapping to this Digital Code (V)
0000	0	-1.875	$-2.0 \leq x < -1.75$
0001	1	-1.625	$-1.75 \leq x < -1.5$
0010	2	-1.375	$-1.5 \leq x < -1.25$
0011	3	-1.125	$-1.25 \leq x < -1.0$
0100	4	-0.875	$-1.0 \leq x < -0.75$
0101	5	-0.625	$-0.75 \leq x < -0.5$
0110	6	-0.375	$-0.5 \leq x < -0.25$
0111	7	-0.125	$-0.25 \leq x < 0.0$
1000	8	+0.125	$0.0 \leq x < 0.25$
1001	9	+0.375	$0.25 \leq x < 0.5$
1010	10	+0.625	$0.5 \leq x < 0.75$
1011	11	+0.875	$0.75 \leq x < 1.0$
1100	12	+1.125	$1.0 \leq x < 1.25$
1101	13	+1.375	$1.25 \leq x < 1.5$
1110	14	+1.625	$1.5 \leq x < 1.75$
1111	15	+1.875	$1.75 \leq x < 2.0$



8. Text, problem 2.27.

The table shows the proportional voltages that result for each 3-bit code.

Digital Code	Proportional Analog Voltage
000	0.0000
001	0.7143
010	1.4286
011	2.1429
100	2.8571
101	3.5714
110	4.2857
111	5.0000

The zero order hold signal for the code 111 101 011 101 000 001 011 010 100 110 is shown.

