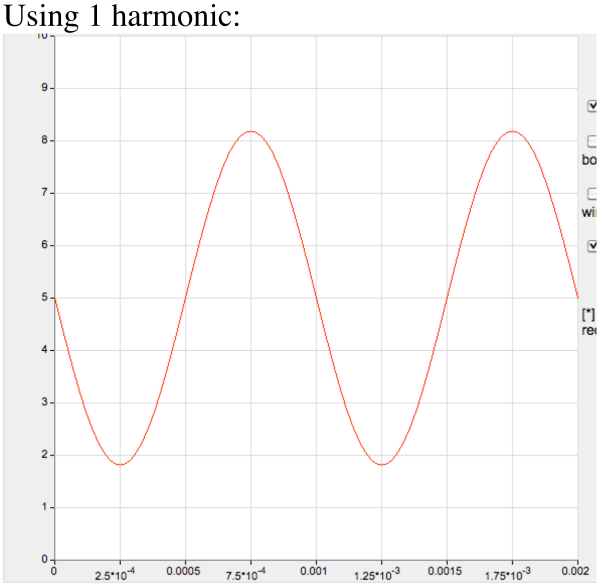
Eugenia Leong
4/22/10
CSE 123 Homework 1

1. Fourier Analysis

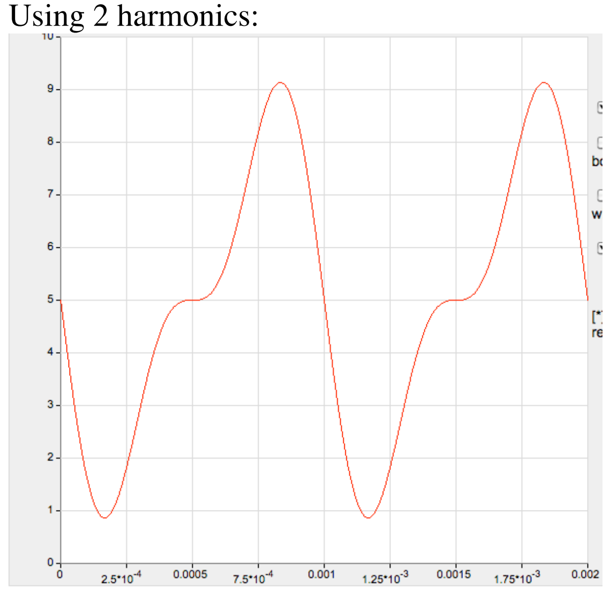
t	f1(t)	f2(t)	f3(t)	f(t)
0.000000	-0.000000	-0.000000	-0.000000	5.000000
0.000100	-1.870979	-1.513653	-1.009102	0.606266
0.000200	-3.027307	-0.935490	0.623659	1.660863
0.000300	-3.027307	0.935489	0.623659	3.531842
0.000400	-1.870979	1.513654	-1.009102	3.633573
0.000500	0.000000	-0.000000	0.000000	5.000000
0.000600	1.870979	-1.513654	1.009102	6.366427
0.000700	3.027307	-0.935490	-0.623659	6.468158
0.000800	3.027307	0.935488	-0.623660	8.339136
0.000900	1.870979	1.513654	1.009102	9.393735
0.001000	-0.000001	-0.000001	-0.000000	4.999997
0.001100	-1.870979	-1.513653	-1.009102	0.606266
0.001200	-3.027307	-0.935489	0.623661	1.660865
0.001300	-3.027306	0.935490	0.623659	3.531842
0.001400	-1.870979	1.513654	-1.009102	3.633572
0.001500	0.000000	-0.000000	0.000000	5.000000
0.001600	1.870977	-1.513653	1.009103	6.366427
0.001700	3.027307	-0.935488	-0.623661	6.468158
0.001800	3.027307	0.935489	-0.623661	8.339136
0.001900	1.870978	1.513653	1.009102	9.393734
0.002000	-0.000001	-0.000001	-0.000000	4.999994

2 periods of the signal can be seen in the first 2 msec.

Using 1 harmonic:



Using 2 harmonics:



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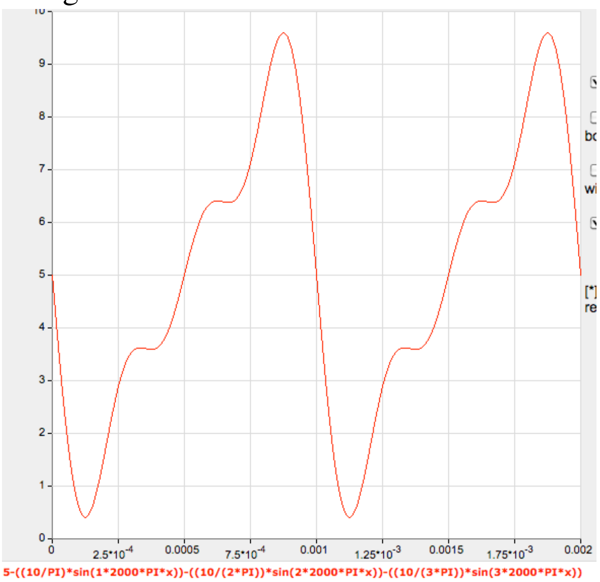
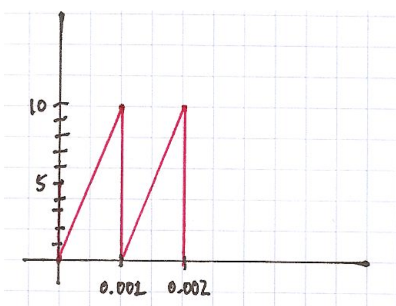
Using 3 harmonics:



The final output shape will look like the following graph when there is enough bandwidth to pass all harmonics:



If the input signal is passed through a channel of bandwidth 1000 Hz, only the first harmonic would pass through. The general form for a harmonic is sin(2πft), so the frequency of the first harmonic, sin(1*2000πt), is f = 1000. Therefore, the output would look like the first graph.

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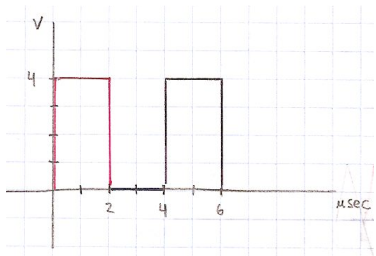
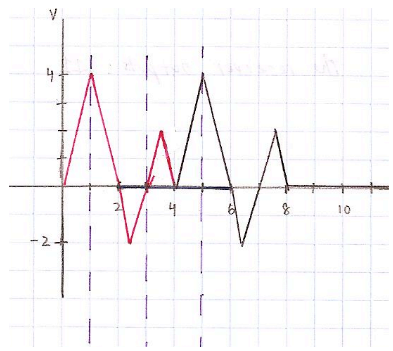
2. Nyquist Limit

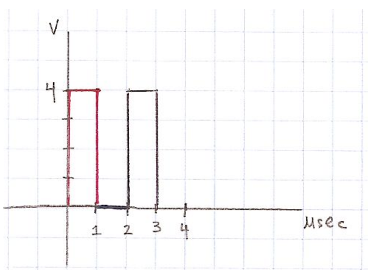
A

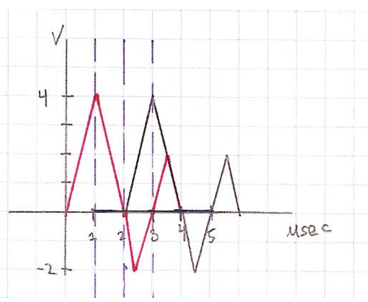




t = 1, V = 4
t = 3, V = 0
t = 5, V = 4
The receiver outputs 101.

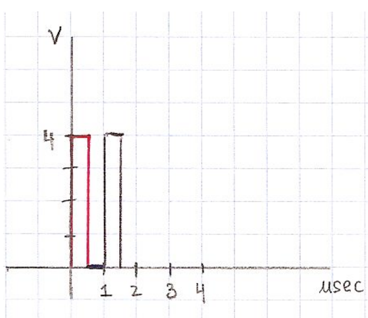
B

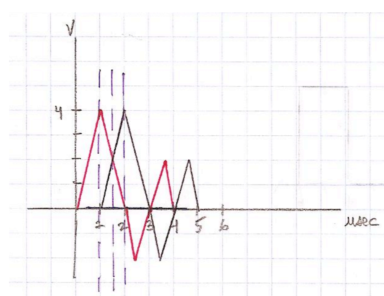




t = 1, V = 4
t = 2, V = 0
t = 3, V = 4
The receiver outputs 101.

C





t = 1, V = 4
t = 1.5, V = 2+2 = 4
t = 2, V = 4
The receiver outputs 111.

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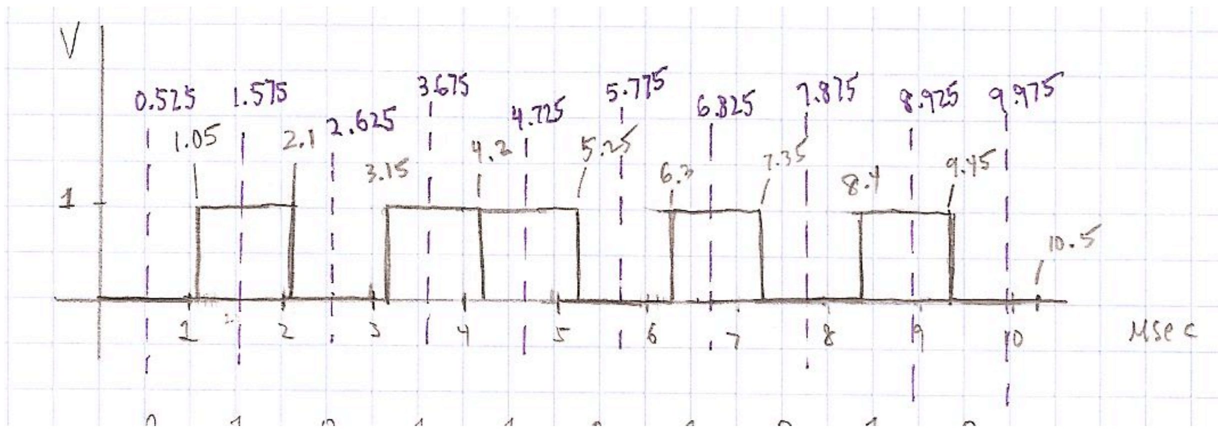
3. Clock Recovery



The tenth bit is sent from 9.45 μsec to 10.5 μsec.
(9.45 + 10.5)/2 = 9.975
Without clock recovery code, sampling occurs at 9.5 μsec.
Sampling is off by 9.975 μsec - 9.5 μsec = 0.475 μsec.

See the graph above for sampling instants (marked in purple).

The spike at 0.4 μsec will not affect sampling times, because the time starts at 0.5 μsec.

The spike at 2.4 μsec will cause the lag to be adjusted. This adjustment will change the sampling times. The sampling times will be adjusted and correct again when a transition occurs at 5.25 μsec.

Extra Credit:
If a spike occurs, the voltage will change back to its original value before the duration of the bit is over. To deal with spikes, make sure the voltage (V) is still the same at a time that is after the duration of a spike and before the duration of the bit is over when a transition occurs. For example, when the bit transitions from 0 to 1, check to make sure that the voltage is still one 0.75 μsec after bit (assuming the spike lasts less than 0.75 μsec). The following is modified pseudo-code:

```
In parallel with Wait look for a Transition if any
      If (Transition is detected at actual time A and
         Voltage at (A + 0.75 μsec) == V)
            lag = A - P;
```