Music 424 Assignment 1

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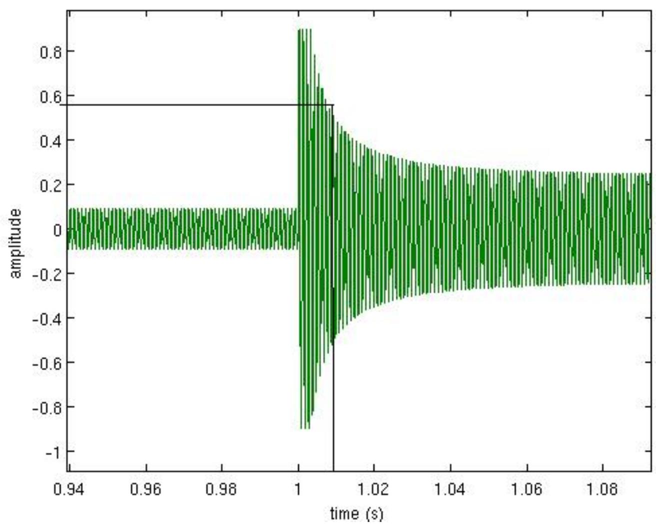
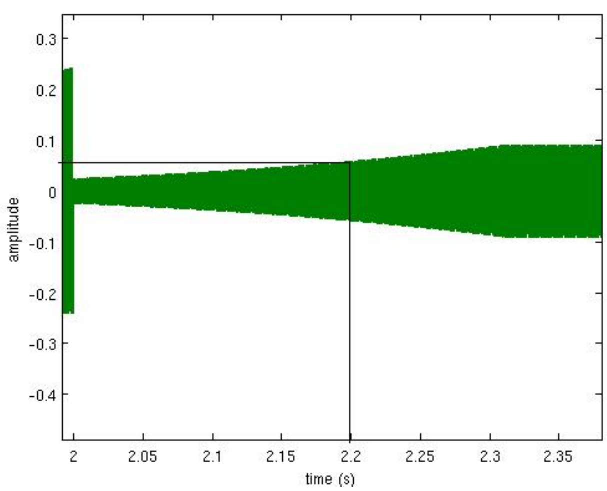
1a) done

1b)
for 10ms attack and 200ms release

Attack:

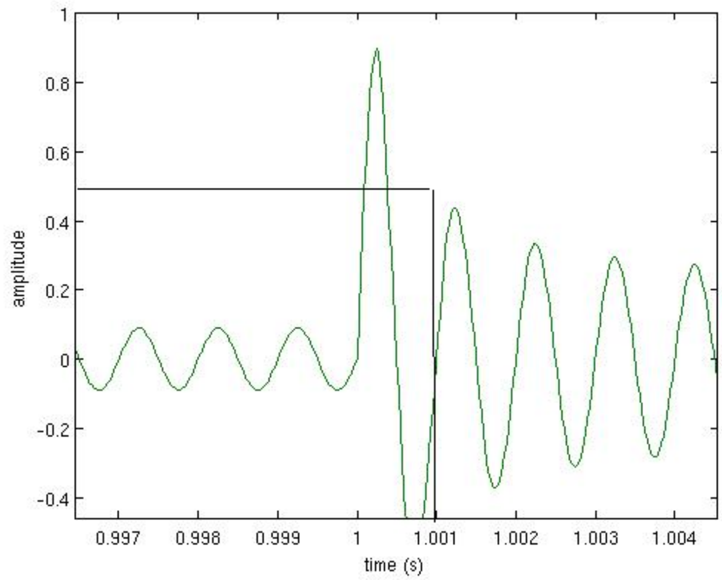


Release:

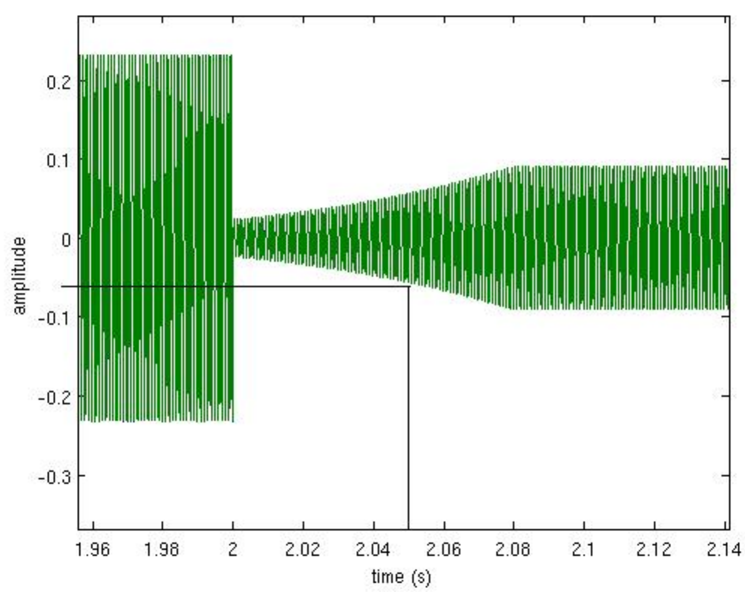


The attack and release times are marked in black for 1ms attack and 50ms release

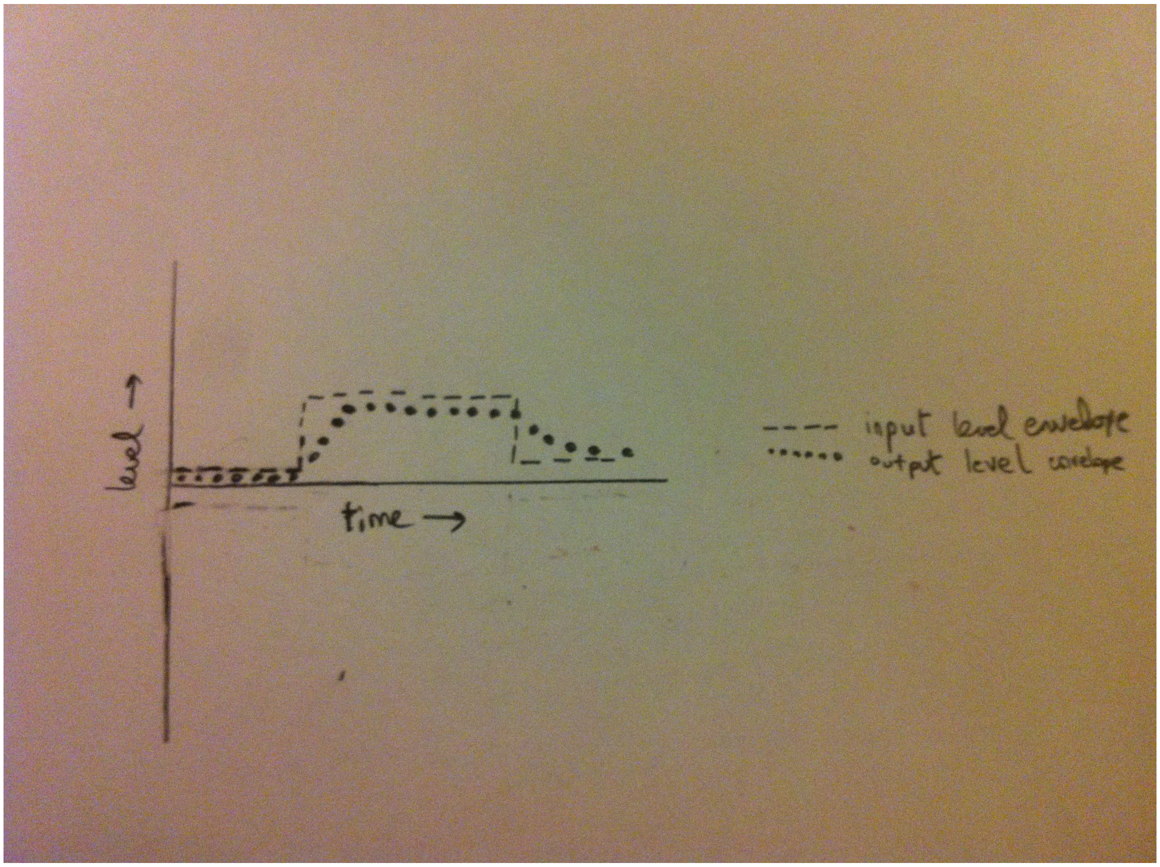
Attack:



Release:



Rough Sketch of envelopes:

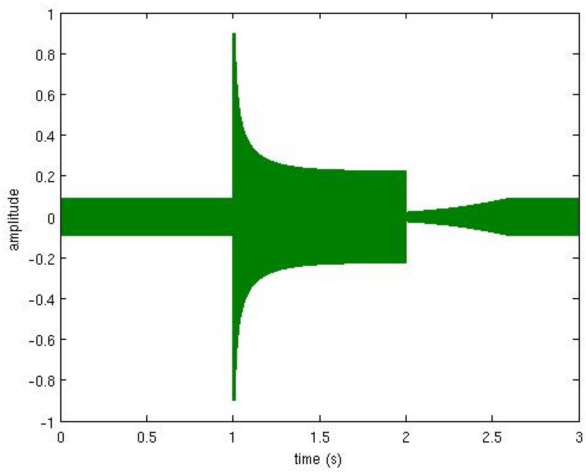


1c)

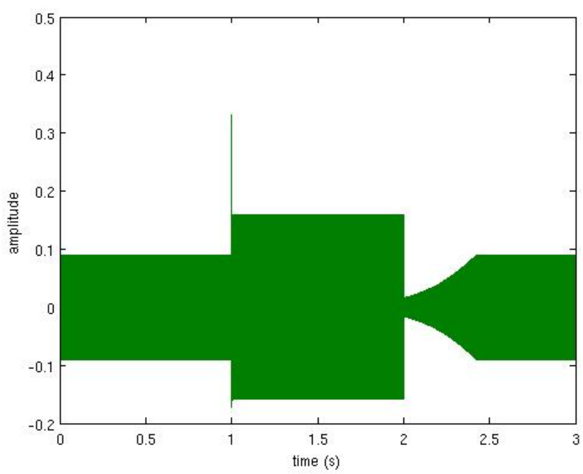
Smooth	0.1ms
Tinky	1ms
Thuddy	50ms
transparent	100ms

Buzzy	50ms
Roomy	100ms
even	200ms

2.
The compressor output is much smoother than the limiter output
Compressor output:

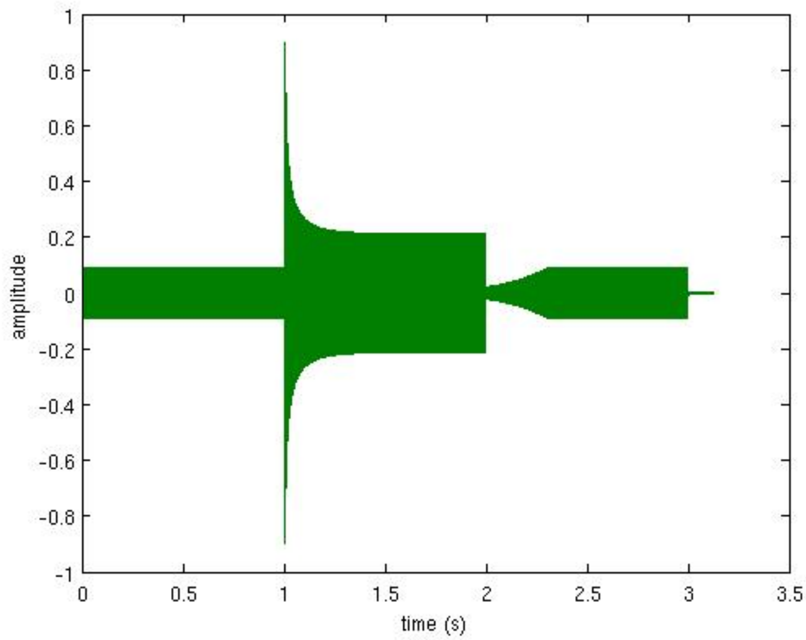


Limiter output:

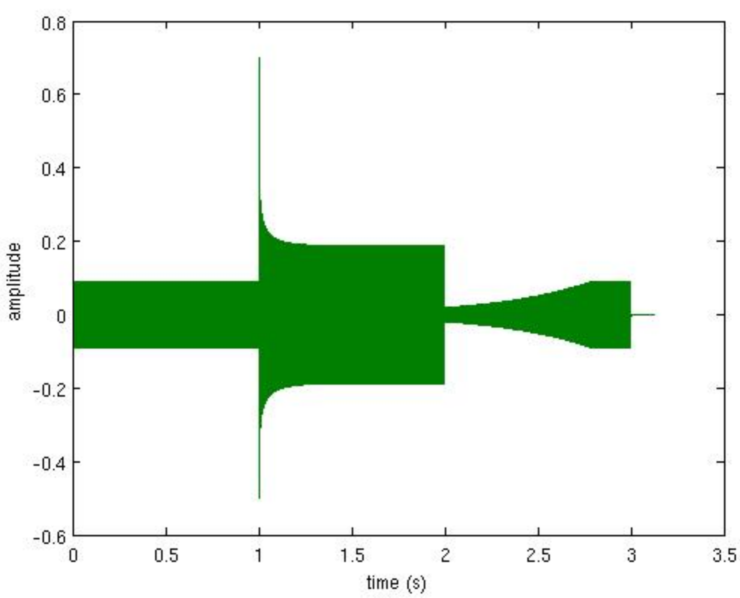


On drums and guitar, the Limiter is a lot more quite than the Compressor and appears much more subdued while the Compressor makes them sound brighter.

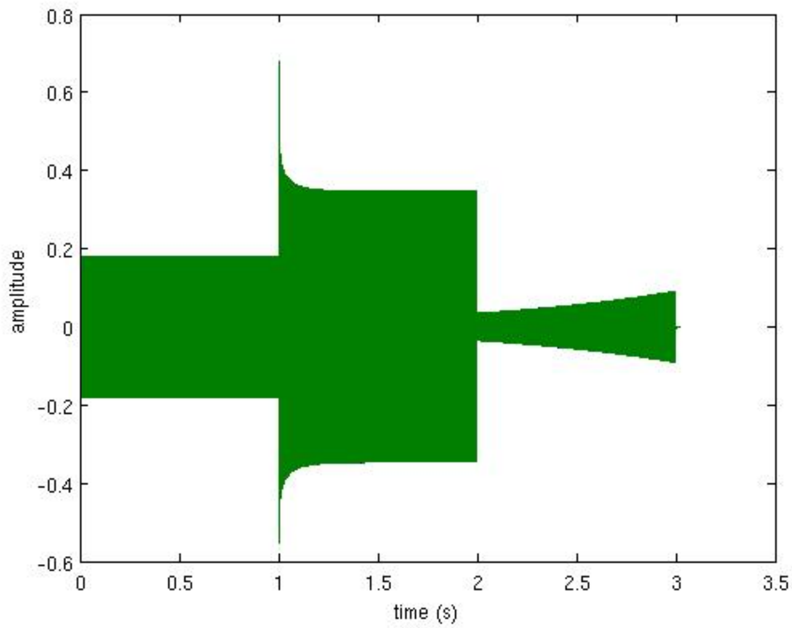
3.a)
p=2



p=5



p=10



3.b) check next page

Let's say the input signal changes from μ to ν at $n = 0$. So when $n < 0, \lambda(n) = \mu,$. When $n \geq 0$,

$$\begin{aligned}
\lambda(n)^p &= (a\lambda(n-1)^p + (1-a)\nu^p) \\
\Rightarrow \lambda(0)^p &= (a\mu^p + (1-a)\nu^p) \\
\Rightarrow \lambda(1)^p &= (a\lambda(0)^p + (1-a)\nu^p) \\
&= (a[(a\mu^p + (1-a)\nu^p)^{1/p}]^p + (1-a)\nu^p) \\
&= (a(a\mu^p + (1-a)\nu^p) + (1-a)\nu^p) \\
&= (a^2\mu^p + a(1-a)\nu^p + (1-a)\nu^p) \\
&= (a^2\mu^p + (a+1)(1-a)\nu^p) \\
\Rightarrow \lambda(2)^p &= (a\lambda(1)^p + (1-a)\nu^p) \\
&= (a[(a^2\mu^p + (a+1)(1-a)\nu^p)^{1/p}]^p + (1-a)\nu^p) \\
&= (a(a^2\mu^p + (a+1)(1-a)\nu^p) + (1-a)\nu^p) \\
&= (a^3\mu^p + (a^2 + a + 1)(1-a)\nu^p) \\
\Rightarrow \lambda(n)^p &= (a^{n+1}\mu^p + (a^n + a^{n-1} \ldots + a + 1)(1-a)\nu^p) \\
&= (a^{n+1}\mu^p + (\frac{1-a^{n+1}}{1-a})(1-a)\nu^p) \\
&= (a^{n+1}\mu^p + (1-a^{n+1})\nu^p)
\end{aligned}$$

We want to find the time constant when $\lambda(n)$ reaches the following value:

$$\begin{aligned}
\mu + (1-1/e)(\nu - \mu) &= (a^{n+1}\mu^p + (1-a^{n+1})\nu^p)^{1/p} \\
\Rightarrow a^{n+1}(\mu^p - \nu^p) + \nu^p &= [\mu + (1-1/e)(\nu-\mu)]^p \\
\Rightarrow a^{n+1} &= \frac{[\mu + (1-1/e)(\nu-\mu)]^p - \nu^p}{\mu^p - \nu^p}
\end{aligned}$$

We know that $a = e^{1/-\tau_0}$and therefore $ln(a) = -1/\tau_0$
When the signal is increasing (attack), $\mu < \nu$, and for simplicity, $\mu =$

$0, \nu = 1$

$$\begin{aligned}
a^{n+1} &= \frac{\nu^p - [\mu + (1-1/e)(\nu-\mu)]^p}{\nu^p - \mu^p} \\
\Rightarrow a^{n+1} &= 1 - (1-1/e)^p \\
\Rightarrow n+1 &= \frac{\ln(1-(1-1/e)^p)}{\ln(a)} \\
&\approx \frac{-(1-1/e)^p,}{\ln(a)} \\
\Rightarrow n &= \tau_0(1-1/e)^p - 1
\end{aligned}$$

The above approximation holds for large p only

When the signal is decreasing (release), $\mu > \nu$, and for simplicity, $\mu = 1, \nu = 0$

$$\begin{aligned}
a^{n+1} &= \frac{[\mu + (1-1/e)(\nu-\mu)]^p - \nu^p}{\mu^p - \nu^p} \\
\Rightarrow a^{n+1} &= (1 + (1-1/e)(-1))^p - 0 \\
\Rightarrow n+1 &= \frac{-p}{\ln(a)} \\
\Rightarrow n &= \frac{-p}{\ln(a)} - 1
\end{aligned}$$

$$n = \tau_0 p - 1$$