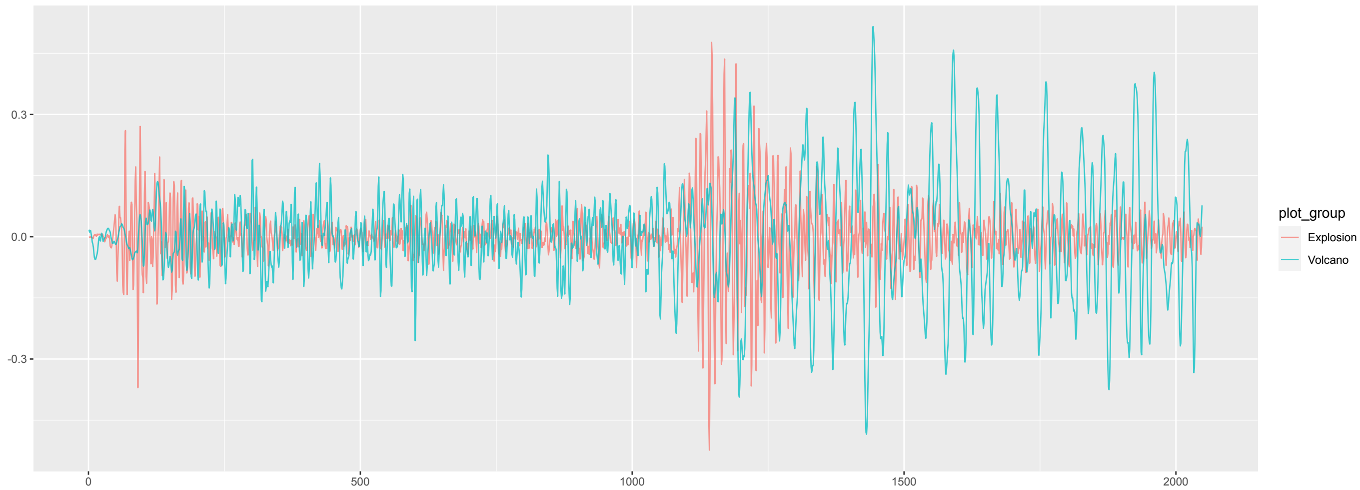
Chapter 1 Homework Problems

Problem 1.1

```r
library(ggplot2)

hw1<-cbind(EXP6,EQ5)
colnames(hw1)<-c("Explosion","Volcano")
autoplot(hw1, facets = FALSE, alpha = 0.75)
```

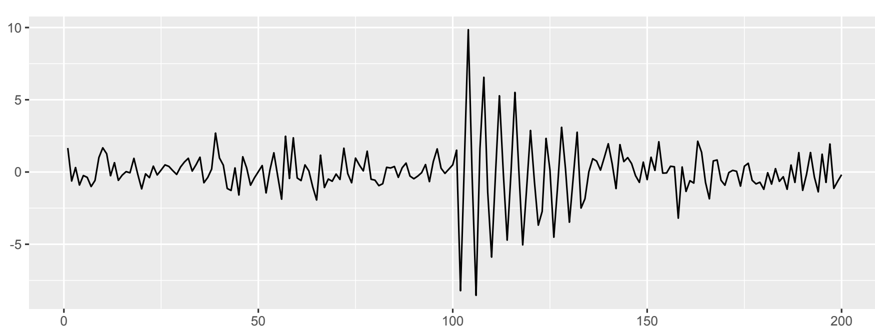


Problem 1.2

(a)

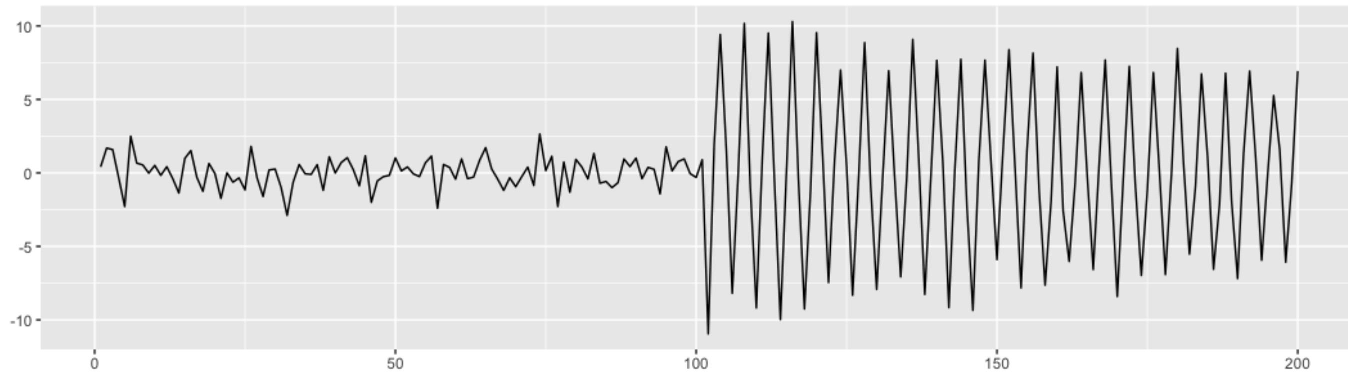
```r
library(ggplot2)
library(ggfortify)
set.seed(1)

s=c(integer(100), 10*exp(-(1:100)/20)*cos(2*pi*1:100/4))
x_a=s+rnorm(200)
autoplot(as.ts(x_a))
```



(b)

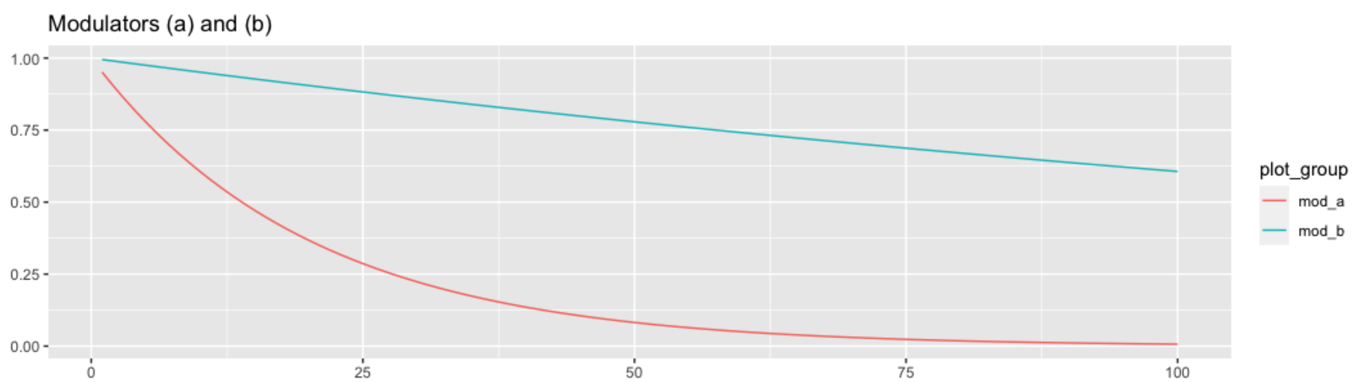
```
s=c(integer(100), 10*exp(-(1:100)/200)*cos(2*pi*1:100/4))
x_b=s+rnorm(200)
autoplot(as.ts(x_b))
```



(c)

The explosion series is similar to series **a**, and the earthquake series is similar to series **b** in their mid-to-end behavior. We see that both series **a** and the explosion series have big amplitudes in the middle that slowly become smaller and tend towards 0 but don't get there. We also see that both series **b** and the earthquake have big amplitudes throughout their mid-to-end behavior.

```
mod_a=exp(-(1:100)/20)
mod_b=exp(-(1:100)/200)
modulators<-as.ts(cbind(mod_a,mod_b))
autoplot(modulators,facets=F,main="Modulators (a) and (b)")
```

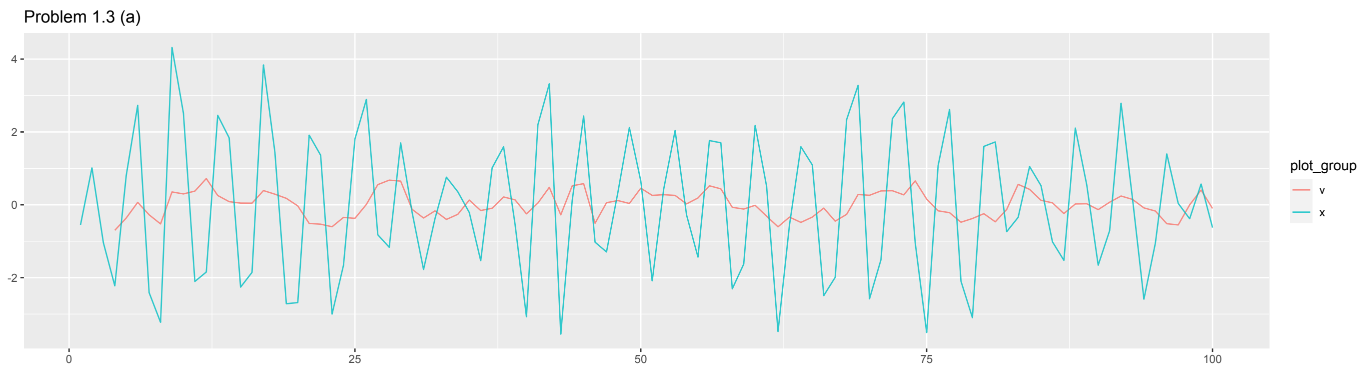


Problem 1.3

(a)

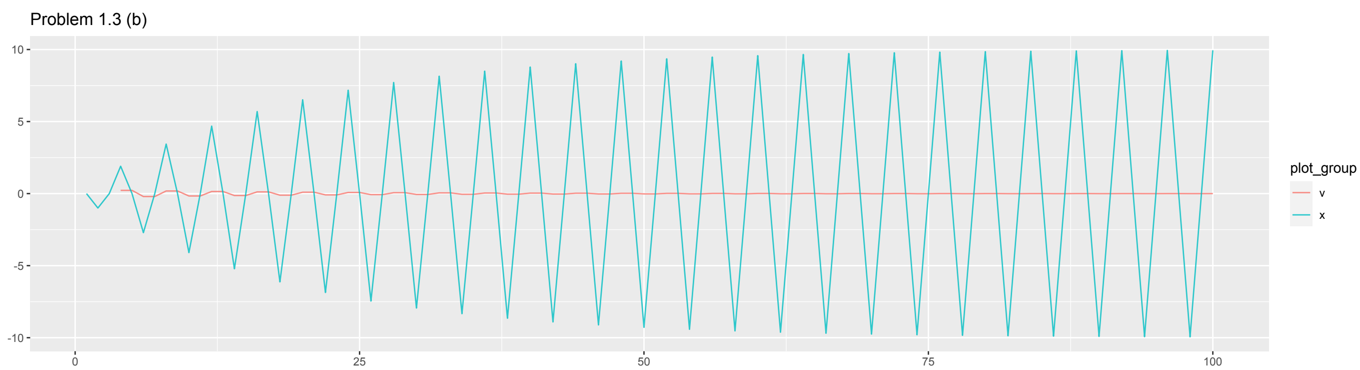
```
library(ggfortify)
library(astsa)

w <- rnorm(150)
x <- filter(w, filter=c(0, -.9), method="recursive")[-(1:50)]
v <- filter(x, rep(1/4, 4), sides = 1)
autoplot(as.ts(cbind(x, v)), main = "Problem 1.3 (a)", facets = F, alpha=0.8)
```



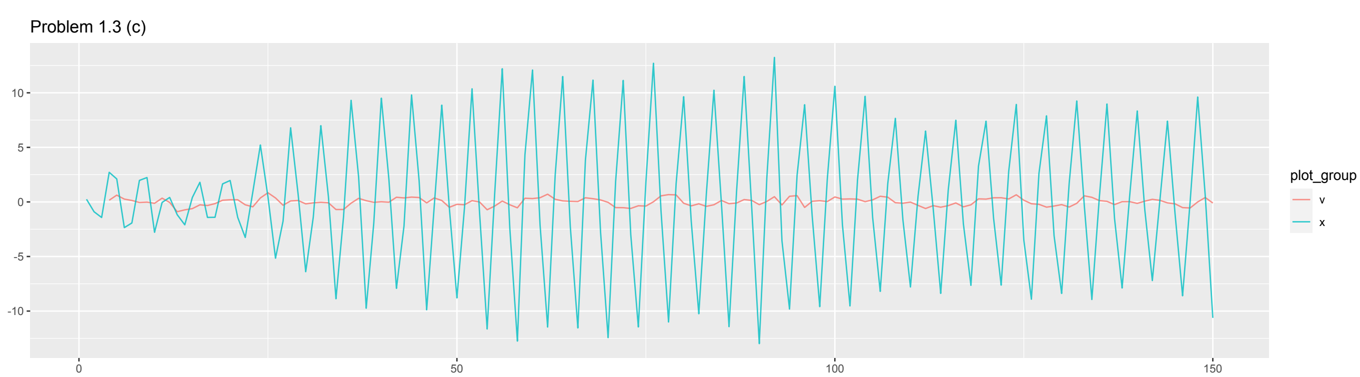
(b)

```r
f <- cos(2*pi*(1:100)/4)
x <- filter(f, filter=c(0, -.9), method="recursive")
v <- filter(x, rep(1/4, 4), sides = 1)
autoplot(as.ts(cbind(x, v)), main = "Problem 1.3 (b)", facets = F, alpha=0.8)
```



(c)

```r
fw <- f+w
x <- filter(fw, filter=c(0, -.9), method="recursive")
v <- filter(x, rep(1/4, 4), sides = 1)
autoplot(as.ts(cbind(x, v)), main = "Problem 1.3 (c)", facets = F, alpha=0.8)
```



(d)

Problem 1.4

Show the following:

$$\mathbf{E}[(x_s - \mu_s)(x_t - \mu_t)] = \mathbf{E}[x_s x_t] - \mu_s \mu_t$$

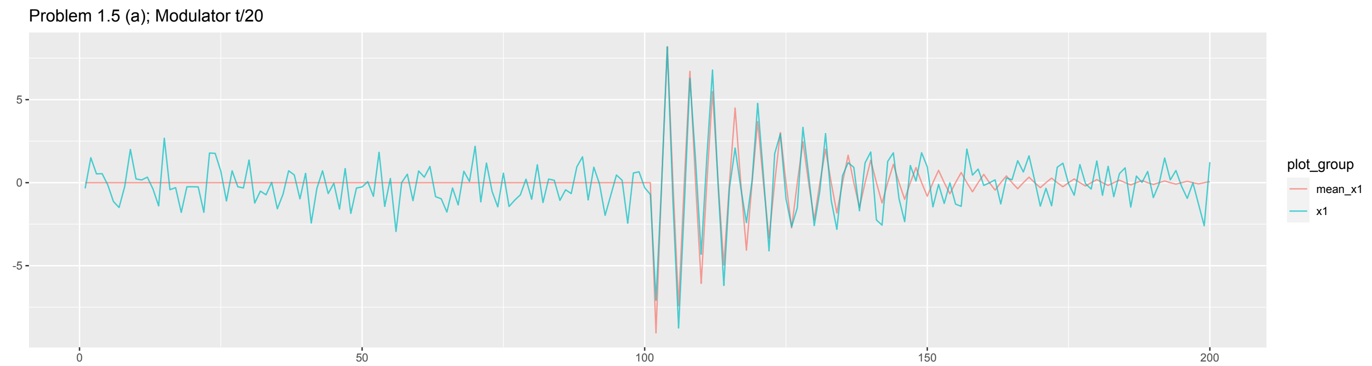
Proof:

> $$\mathbf{E}[(x_s - \mu_s)(x_t - \mu_t)] = \mathbf{E}[x_s x_t - x_s \mu_t - x_t \mu_s + \mu_s \mu_t] = \mathbf{E}[x_s x_t] - \mu_t \mathbf{E}[x_s] - \mu_s \mathbf{E}[x_t] + \mu_s \mu_t$$
> $$\mathbf{E}[x_s x_t] - \mu_t \mu_s - \mu_s \mu_t + \mu_s \mu_t = \mathbf{E}[x_s x_t] - \mu_s \mu_t$$
> $$\implies \mathbf{E}[(x_s - \mu_s)(x_t - \mu_t)] = \mathbf{E}[x_s x_t] - \mu_s \mu_t$$

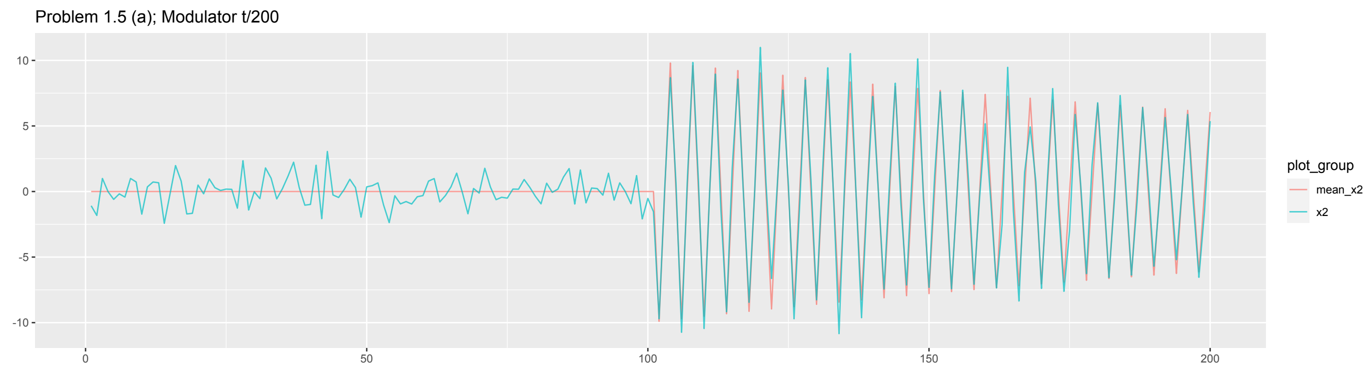
Problem 1.5

(a)

```r
mean_x1 <- c(integer(100), 10*exp(-(1:100)/20)*cos(2*pi*1:100/4))
x1 <- mean_x1 + rnorm(200)
autoplot(as.ts(cbind(x1,mean_x1)), main = "Problem 1.5 (a); Modulator t/20", facets = F, alpha=0.7)
```




```r
mean_x2 <- c(integer(100), 10*exp(-(1:100)/200)*cos(2*pi*1:100/4))
x2 <- mean_x2 + rnorm(200)
autoplot(as.ts(cbind(x2,mean_x2)), main = "Problem 1.5 (a); Modulator t/200", facets = F,
alpha=0.7)
```



(b)