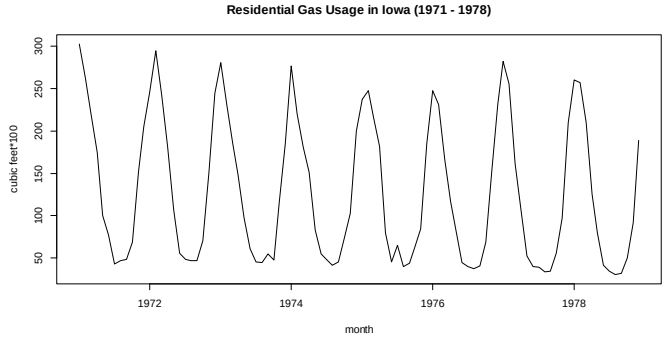
Department of Statistics
STATS 326: Applied Time Series
Summer Semester, 2019
Test 2

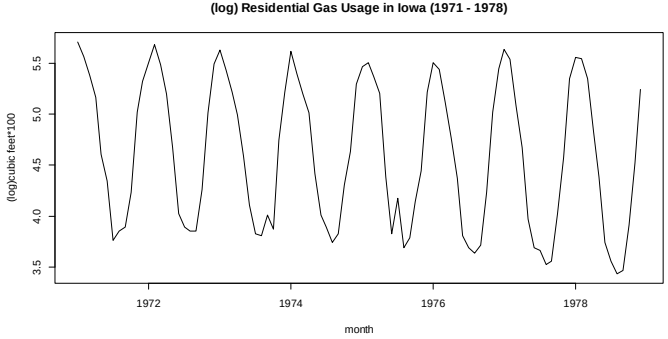
Appendices

Data: Monthly measurements of Residential Gas Usage (cubic feet * 100) for Iowa, USA between 1971 and 1978. The actual values for January – March 1979 are also given.

```
> Res.Gas.df = read.table(file.choose(),header=T)
> names(Res.Gas.df)
[1] "Usage"
> gas.usage.ts = ts(Res.Gas.df$Usage,start=1971,frequency=12)
> plot(gas.usage.ts,main="Residential Gas Usage in Iowa (1971 -
   1978)",xlab="month",ylab="cubic feet*100")
```



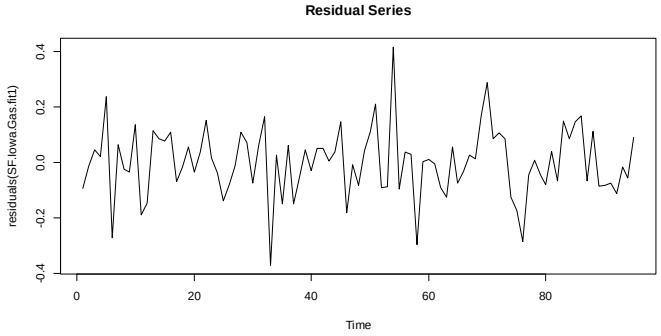

```
> plot(log(gas.usage.ts),main="(log) Residential Gas Usage in Iowa (1971 -
   1978)",xlab="month",ylab="(log)cubic feet*100")
```



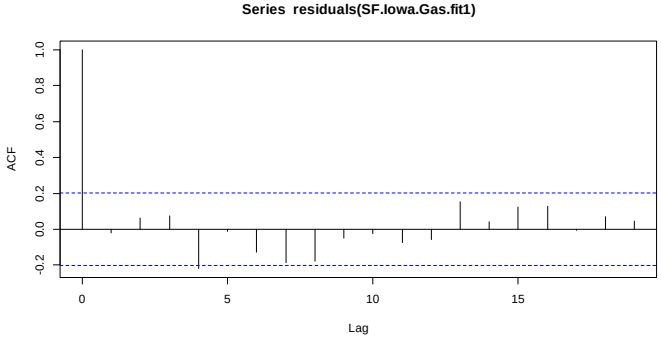

```
> actual = c(256,250,198)
> names(actual) = c("Jan 79","Feb 79","Mar 79")
> actual
Jan 79 Feb 79 Mar 79
   256    250    198
```


Seasonal Factor Model:

```
> Month = factor(rep(1:12,8))

> SF.Iowa.Gas.fit1 = lm(log(gas.usage.ts[-1])~Time[-1]+Month[-1]+
   log(gas.usage.ts[-96]))

> plot.ts(residuals(SF.Iowa.Gas.fit1),main="Residual Series")
```




```
> acf(residuals(SF.Iowa.Gas.fit1))
```



```
> summary(SF.Iowa.Gas.fit1)

Call:
lm(formula = log(gas.usage.ts[-1]) ~ Time[-1] + Month[-1] +
log(gas.usage.ts[-96]))

Residuals:
     Min       1Q   Median       3Q      Max
-0.37061 -0.07731  0.00582  0.07588  0.41676

Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)            4.1101689  0.5891943   6.976 7.51e-10 ***
Time[-1]              -0.0025536  0.0006366  -4.012 0.000134 ***
Month[-1]2            -0.1324948  0.0732650  -1.808 0.074251 .
Month[-1]3            -0.3500717  0.0713510  -4.906 4.72e-06 ***
Month[-1]4            -0.5722269  0.0695613  -8.226 2.69e-12 ***
Month[-1]5            -1.0397194  0.0791776 -13.131  < 2e-16 ***
Month[-1]6            -1.3518803  0.1194941 -11.313  < 2e-16 ***
Month[-1]7            -1.3442199  0.1634076  -8.226 2.69e-12 ***
Month[-1]8            -1.4167732  0.1763259  -8.035 6.41e-12 ***
Month[-1]9            -1.3093899  0.1873272  -6.990 7.05e-10 ***
Month[-1]10           -0.9664979  0.1800081  -5.369 7.38e-07 ***
Month[-1]11           -0.4461130  0.1449598  -3.077 0.002848 **
Month[-1]12           -0.0518987  0.0919605  -0.564 0.574070
log(gas.usage.ts[-96])  0.2956986  0.1063287   2.781 0.006738 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1336 on 81 degrees of freedom
Multiple R-squared:  0.9697,    Adjusted R-squared:  0.9648
F-statistic: 199.2 on 13 and 81 DF,  p-value: < 2.2e-16
```

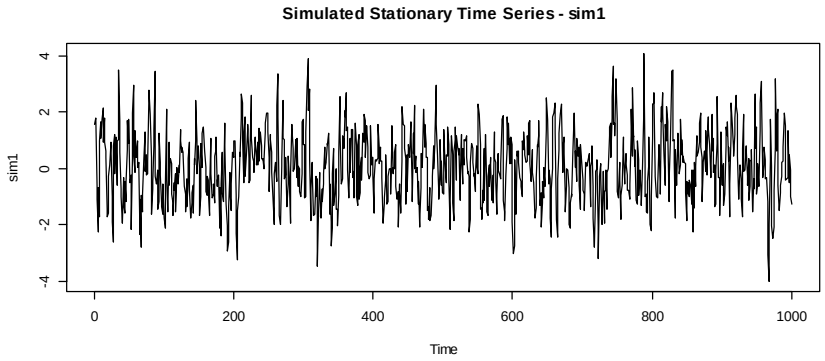

Reduced Harmonic Model – significant harmonic pairs:

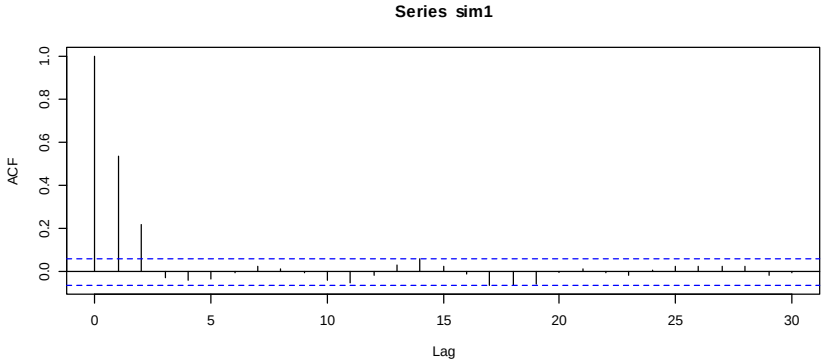
```
> RHP.Iowa.Gas.fit1 = lm(log(gas.usage.ts[-1])~Time[-1]+c1[-1]+s1[-1]+
   c2[-1]+s2[-1]+c3[-1]+s3[-1]+log(gas.usage.ts[-96]))
> summary(RHP.Iowa.Gas.fit1)

Call:
lm(formula = log(gas.usage.ts[-1]) ~ Time[-1] + c1[-1] + s1[-1] +
    c2[-1] + s2[-1] + c3[-1] + s3[-1] + log(gas.usage.ts[-96]))

Residuals:
     Min       1Q   Median       3Q      Max
-0.35050 -0.08557  0.01126  0.08087  0.46108

Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)            3.4811573  0.4975624   6.996 5.39e-10 ***
Time[-1]              -0.0026490  0.0006277  -4.220 6.03e-05 ***
c1[-1]                 0.5743754  0.0254769  22.545  < 2e-16 ***
s1[-1]                 0.4884427  0.1010552   4.833 5.81e-06 ***
c2[-1]                 0.0639224  0.0191775   3.333 0.001268 **
s2[-1]                 0.0205739  0.0207075   0.994 0.323231
c3[-1]                 0.0686927  0.0191701   3.583 0.000562 ***
s3[-1]                -0.0331946  0.0206859  -1.605 0.112226
log(gas.usage.ts[-96])  0.2707276  0.1039463   2.604 0.010839 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1324 on 86 degrees of freedom
Multiple R-squared:  0.9684,    Adjusted R-squared:  0.9654
F-statistic: 329.3 on 8 and 86 DF,  p-value: < 2.2e-16

> t97.rhp.pred
    5.40152

> t98.rhp.pred
   5.311252

> t99.rhp.pred
   5.114524
```

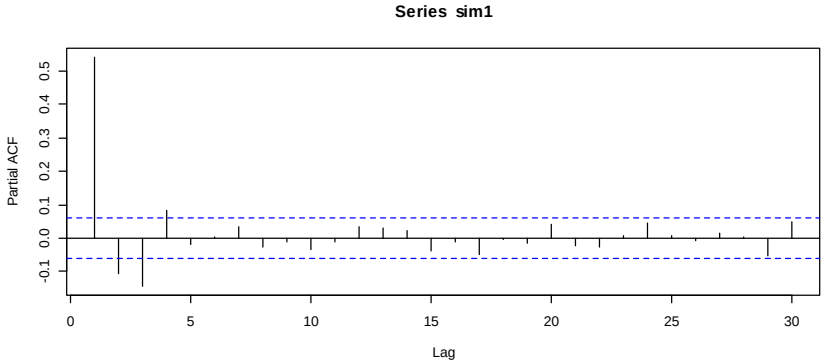
Test 1 model RMSEP statistics:

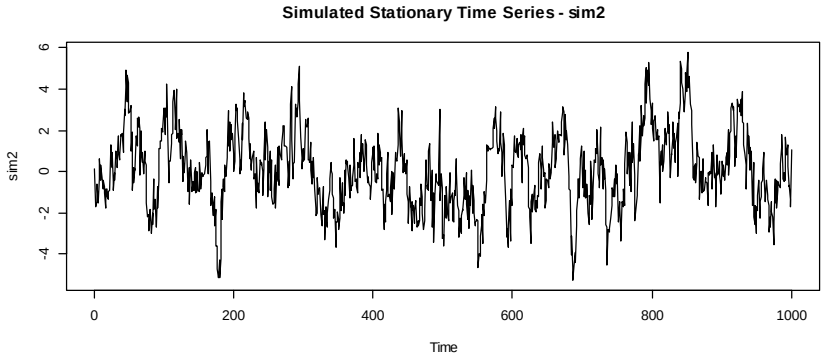
```
> HW.RMSEP
[1] 29.69486

> MA.RMSEP
[1] 36.9548

> STL.RMSEP
[1] 38.34974
```

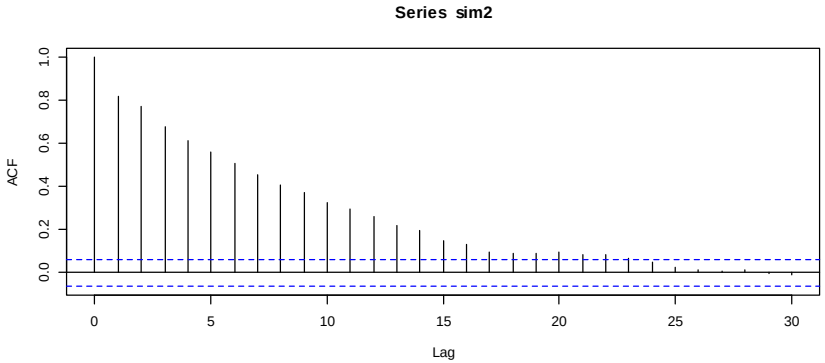
Simulated Stationary Time Series:

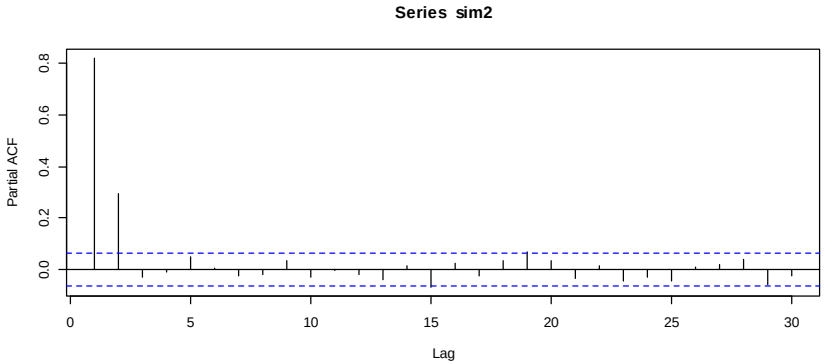


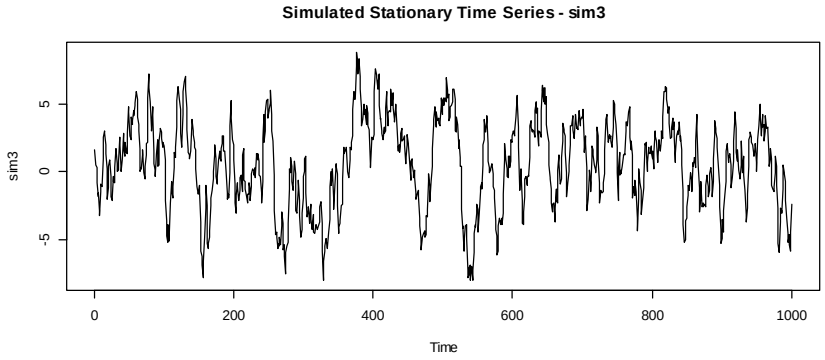


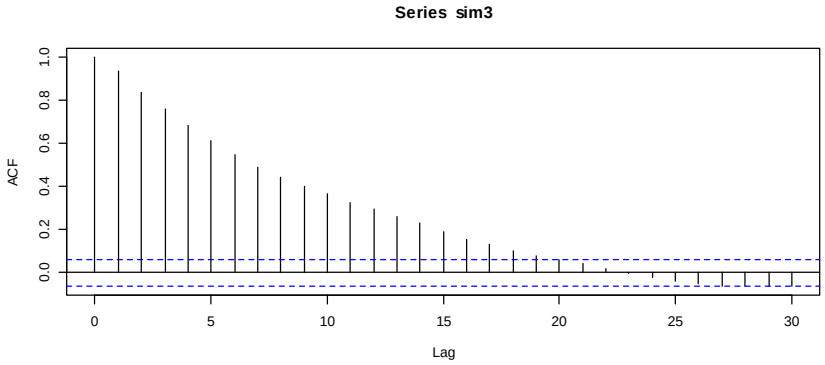


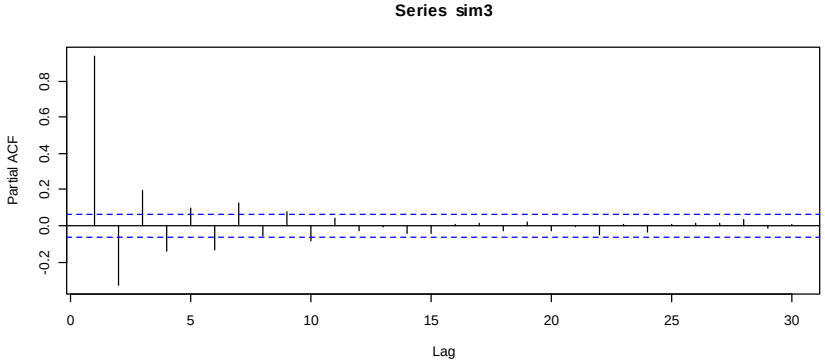


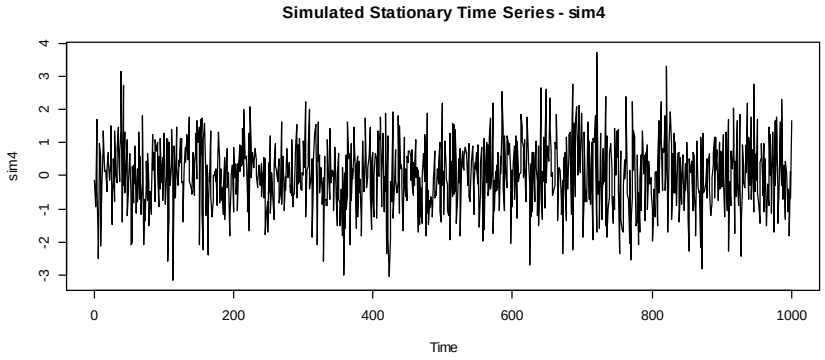


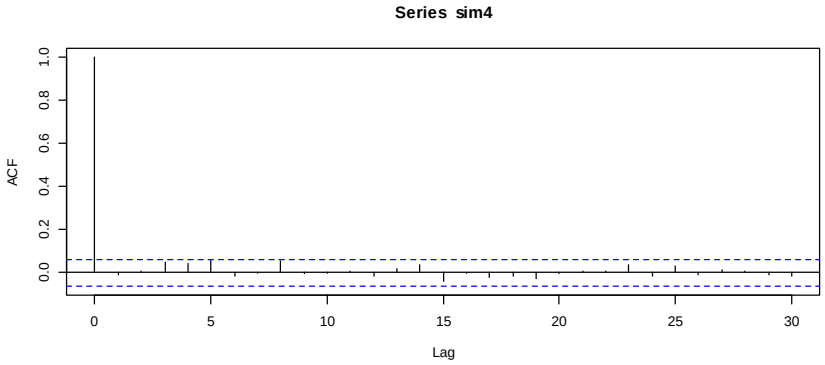


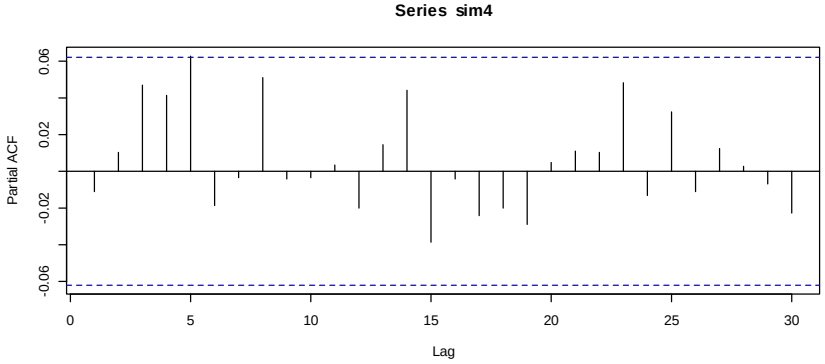

Simulated Stationary Time Series - sim3
sim3
Time


Series sim3
ACF
Lag


Series sim3
Partial ACF
Lag


Simulated Stationary Time Series - sim4
sim4
Time


Series sim4
ACF
Lag


Series sim4
Partial ACF
Lag