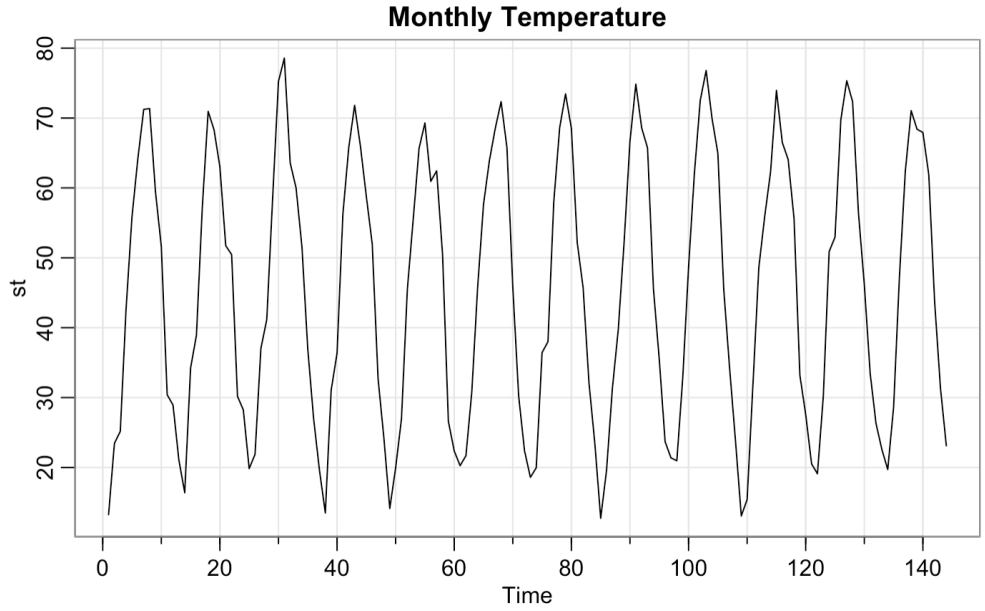
1a)



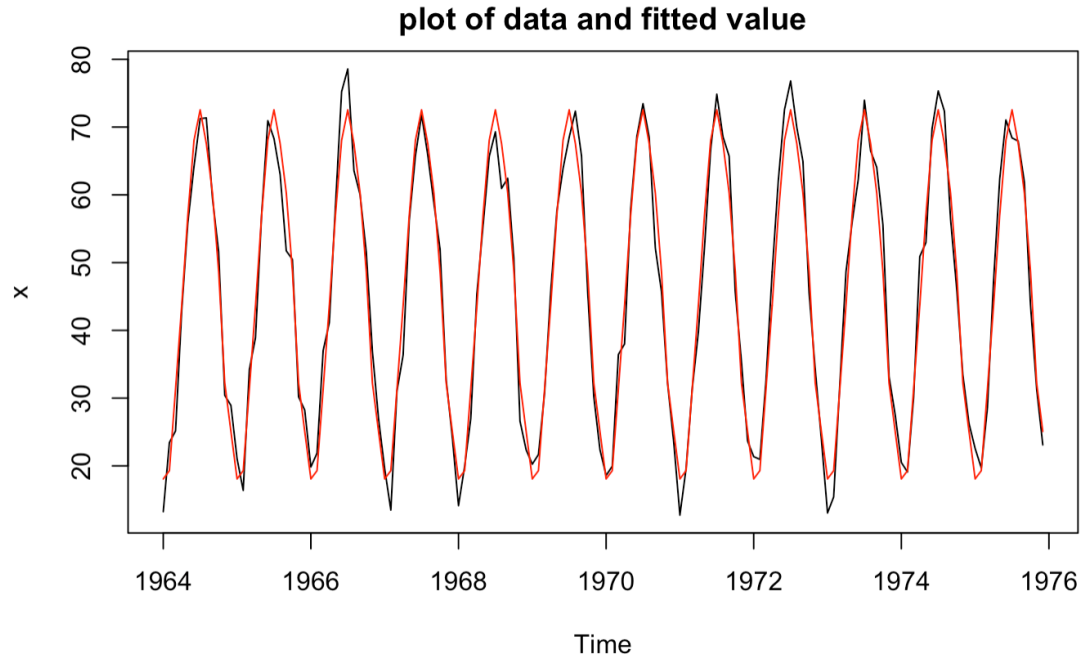
From the plot of xt, the seasonal data added to the white noise data, we can see that the monthly temperature tends to have a fluctuation cycle lasting about between 12 months. In this cycle, the monthly temperature increases for half of the time, usually from somewhere around 15-20 degrees all the way to around 70 degrees. Once it reaches this temperature, it begins to fall at the same level it rose until it reaches around to where it was in the beginning of the yearly cycle. This cycle is followed every year for 12 years.

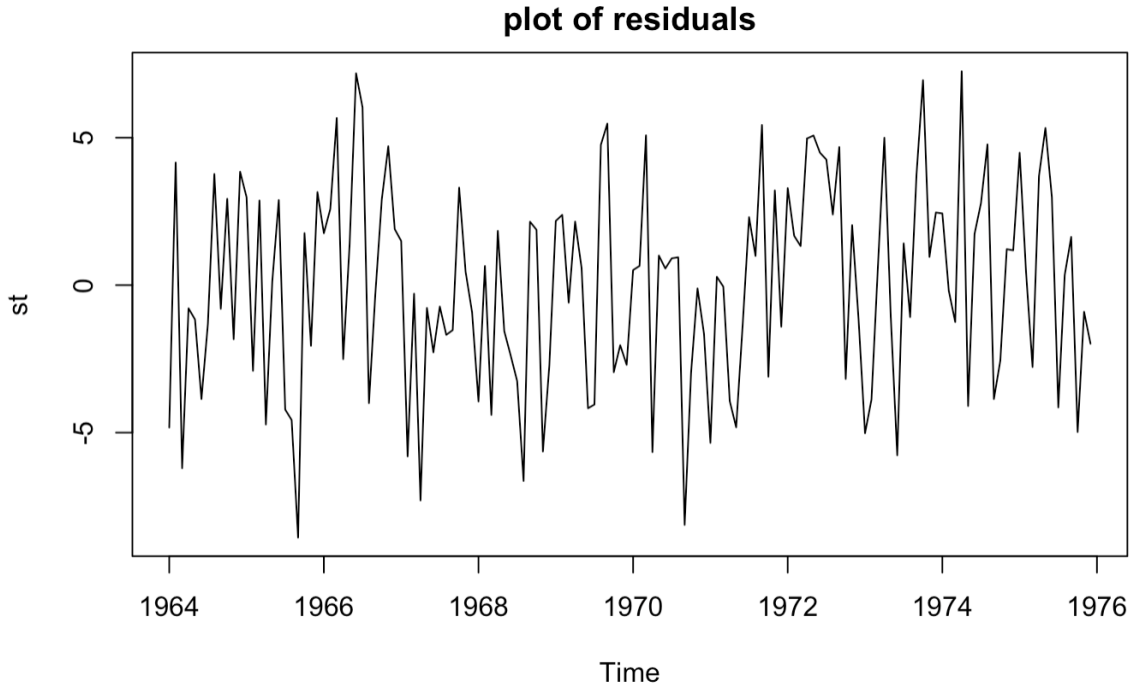
1b)

```
Call:
lm(formula = st ~ 0 + M, na.action = NULL)

Residuals:
    Min      1Q  Median      3Q     Max
-8.5585 -2.7064  0.3811  2.4929  7.2519

Coefficients:
    Estimate Std. Error t value Pr(>|t|)
M1     18.08       1.05   17.21   <2e-16 ***
M2     19.29       1.05   18.37   <2e-16 ***
M3     31.37       1.05   29.87   <2e-16 ***
M4     43.65       1.05   41.57   <2e-16 ***
M5     57.05       1.05   54.33   <2e-16 ***
M6     68.06       1.05   64.81   <2e-16 ***
M7     72.54       1.05   69.08   <2e-16 ***
M8     67.58       1.05   64.36   <2e-16 ***
M9     60.29       1.05   57.41   <2e-16 ***
M10    48.71       1.05   46.38   <2e-16 ***
M11    32.24       1.05   30.70   <2e-16 ***
M12    25.09       1.05   23.89   <2e-16 ***
```

From January to July it increases from 18,08 to 72.54, From July to December it decreases from 72.54 to 25.09. Between these two time frames the temperatures are decreasing and increasing monthly.

(ii)





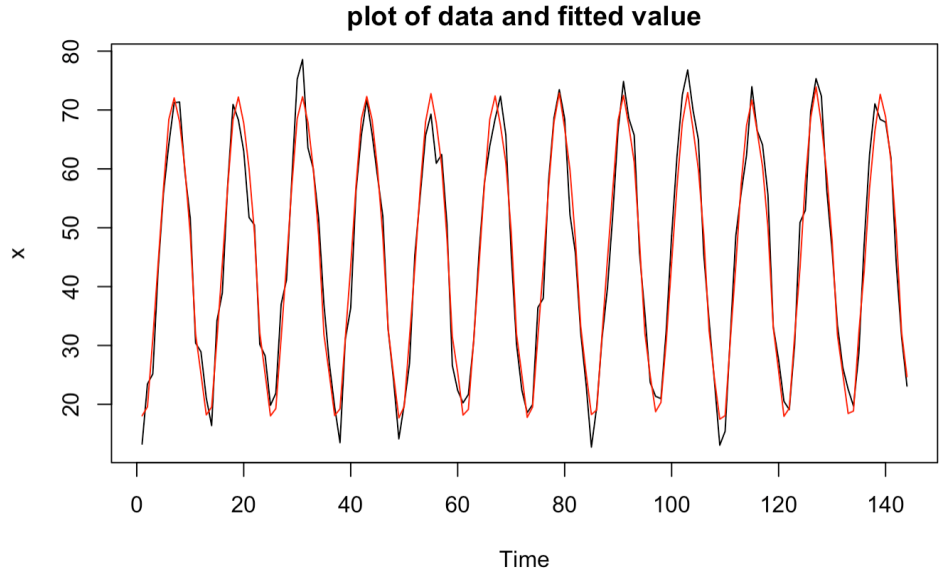
I would say that the model does fit the data well. It does follow the yearly trend really well, but misses out slightly when the temperatures reach relay high or low. However the model does a good job of replicating the data. From the residuals plot, we can see that the residuals do look random and somewhat normal.

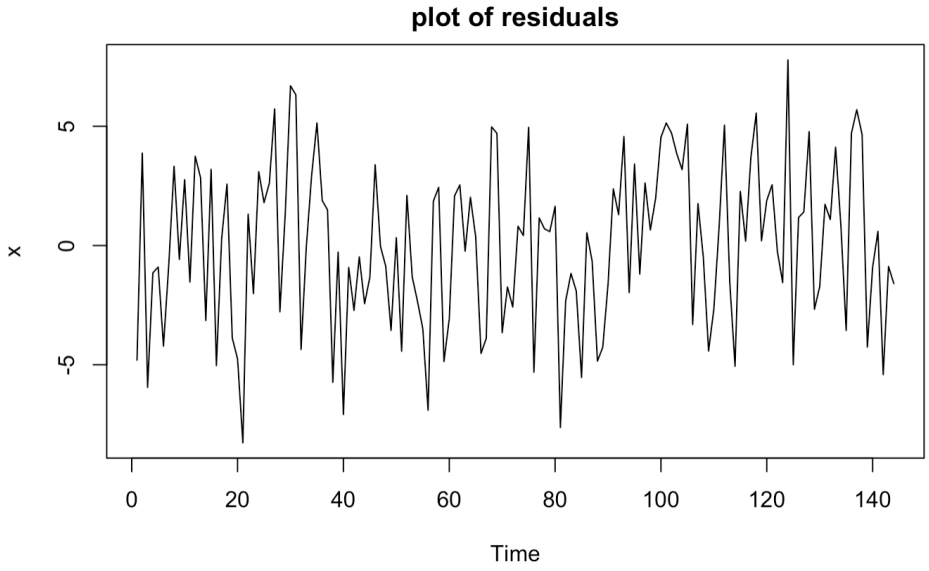
1c)
(i)

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  4.536e+01  3.014e-01 150.512   <2e-16 ***
cos_1       -2.218e+01  4.258e-01 -52.087   <2e-16 ***
sin_1       -1.498e+01  4.256e-01 -35.197   <2e-16 ***
cos_2        2.652e-01  4.261e-01   0.622   0.5348
sin_2       -5.835e-01  4.256e-01  -1.371   0.1728
cos_3        4.565e-02  4.255e-01   0.107   0.9147
sin_3       -5.367e-02  4.274e-01  -0.126   0.9003
cos_4        8.435e-01  4.258e-01   1.981   0.0497 *
sin_4        9.748e-01  4.256e-01   2.291   0.0236 *
cos_5        5.329e-01  4.338e-01   1.228   0.2215
sin_5        4.573e-01  4.265e-01   1.072   0.2856
cos_6        3.696e-01  3.480e-01   1.062   0.2902
sin_6        3.074e+13  1.779e+13   1.727   0.0865 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

From the model summary, we can see that at a significance level of 0.01, the frequencies that are significant arecos_1, sin_1, sin_4, and cos_4. The time series will repeat itself every 12 months.

(ii)





(iii) I would say that the model fits the data really well, it follows the same yearly cycle as the data and almost collows the data exactly. The residuals look white and random, however, based on further analysis, I would not say that the residuals are normal. Using a qqplot and histogram of the residuals, the residuals do not appear bell shaped.

R Appendix

```{r}
library(astsa)
data<-read.csv('~/Downloads/Project_1_Data.csv')
data<-ts(data)
data
```
```{r}
st <- data
wt <- rnorm(144,0,1)
xt<- st+wt
tsplot(st, main = 'Monthly Temperature')
tsplot(wt)
tsplot(xt, col=6, main='Monthly Temperature')
```
```{r}
st<-ts(st, start=c(1964, 1), end=c(1975, 12), frequency =12)
st
```
```{r}
trend <- time(st)
M<-factor(cycle(st))

model <- lm(st~0 + M, na.action=NULL)
summary(model)
```
```{r}
plot(st, main="plot of data and fitted value")
lines(fitted(model), col="red")
plot(st-fitted(model), main="plot of residuals")
```
```{r}
t= 1:length(data)
t
k<-1:6
k
```
```{r}
df<-data.frame(X=data, cos_1 = cos((2*1*pi*t)/12), sin_1 = sin((2*1*pi*t)/12),cos_2 =
cos((2*2*pi*t)/12), sin_2 = sin((2*2*pi*t)/12),cos_3 = cos((2*3*pi*t)/12), sin_3 =
sin((2*3*pi*t)/12),cos_4 = cos((2*4*pi*t)/12), sin_4= sin((2*4*pi*t)/12),cos_5 = cos((2*5*pi*t)/12),
sin_5 = sin((2*5*pi*t)/12),cos_6 = cos((2*6*pi*t)/12), sin_6 = sin((2*6*pi*t)/12))
df
```

```{r}
model_2 <- lm(data ~ cos_1 +sin_1 +cos_2 +sin_2+cos_3 +sin_3+cos_4+sin_4+cos_5
+sin_5+cos_6 +sin_6, data=df)
summary(model_2)
```
```{r}
plot(data, main="plot of data and fitted value")
lines(fitted(model_2), col="red")
plot(data-fitted(model_2), main="plot of residuals")
```
```{r}
qqnorm(data-fitted(model_2))
qqline(data-fitted(model_2), col = "steelblue", lwd = 2)
```