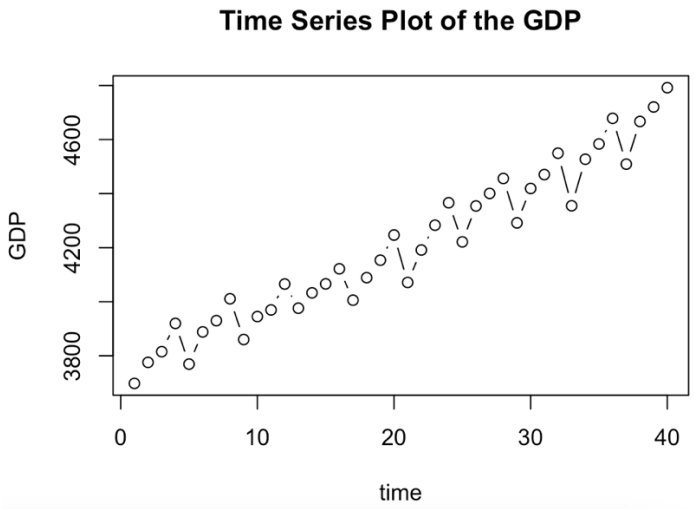
a) The time series plot of the gdp shows that there is increasing trend in general. This means that generally, as t increases, the GDP increases. There is persistent increase in mean response as t increases. Also, there is quarterly seasonal variation in this time series data since we find that the points show increasing pattern for four points and decreases at the fifth point, then increases again for four points, and so on. In other words, the time series plot suggests a strong seasonal pattern recurring every 4 time units(quarters).

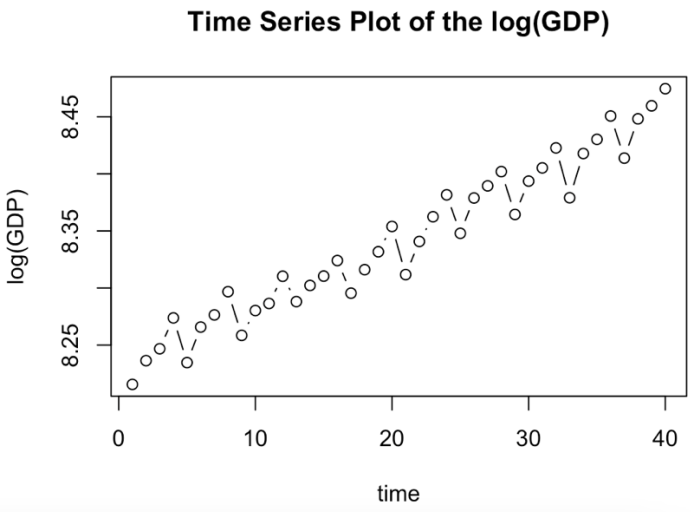
```
GDP_US <- read.csv("~/Desktop/STAT 371/a4/GDP_US.csv")
attach(GDP_US)

# a)
 plot(GDP,type="b",xlab="time",main="Time Series Plot of the GDP")
```



b) By observing this plot, we find that this plot also shows that there is increasing trend in general. There is persistent increase in mean response as t increases. This plot suggests a strong seasonal pattern recurring every 4 time units(quarters). Comparing this plot with the plot in a), we find that the variation of y-axis become steady. This means that since the values of y-axis in this plot are much smaller than the values of y-axis in the time series plot of the gdp in part a), the variation or the fluctuation of y-axis is more stable by taking the log transformation of the series. In other words, because of the log transformation of gdp, the range of y-axis of this plot is narrower than the plot in part a) and so the variation or the fluctuation of the log transformation of gdp is more stable than gdp.

```
# b)
 plot(log(GDP),type="b",xlab="time",main="Time Series Plot of the log(GDP)")
```



c) The R-squared is 0.9928. This indicates that approximately 99.28% of the variation on the log transformation of GDP is accounted for by the variables in the model, including the observed seasonal component, which is Quarter, and linear trend. Since p-value is smaller than 2.2*10^(-16), we should reject null hypothesis and conclude that variables in this model, including the observed seasonal component, which is Quarter, and linear trend are significantly related to the log transformation of GDP.

```
# c)
GDP_US$time <- c(1:40)
Q <- as.factor(Quarter)
gdplm <- lm(log(GDP)~Q+time,data=GDP_US)
summary(gdplm)
```

```
Call:
lm(formula = log(GDP) ~ Q + time, data = GDP_US)

Residuals:
       Min         1Q     Median         3Q        Max
-0.0111854 -0.0030939  0.0003585  0.0044590  0.0109620

Coefficients:
             Estimate Std. Error  t value Pr(>|t|)
(Intercept) 8.204e+00  2.536e-03 3234.947  < 2e-16 ***
QQ2         2.145e-02  2.765e-03    7.757 4.14e-09 ***
QQ3         2.770e-02  2.769e-03   10.002 8.44e-12 ***
QQ4         4.123e-02  2.776e-03   14.854  < 2e-16 ***
time        5.635e-03  8.505e-05   66.256  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.00618 on 35 degrees of freedom
Multiple R-squared:  0.9928,    Adjusted R-squared:  0.992
F-statistic:  1214 on 4 and 35 DF,  p-value: < 2.2e-16
```