Problem1

The function of skewness is unbiased, and the function of kurtosis is biased.

```
mean kurts -0.00016189984332937524
var kurts 0.0002502801989064205
std kurts 0.0158202464869047
mean skew -0.00020365550767820892
var skew 6.124760215470616e-05
std skew 0.007826084727033446
p-value for kurtosis: 0.0
p-value for skewness: 0.4109903269833499
```

Since the p-value of skewness is 0.4109903269833499 which is not significantly different from 0, so the skewness is a normal distribution. This means that the distribution of the sample data is likely symmetric and not skewed in one direction or another.
Since the p-value of kurtosis is 0, it indicates that the sample kurtosis is significantly different from 0. This means that the distribution of the sample data is not normal and has "fatter" tails or more extreme values than a normal distribution.

Problem 2

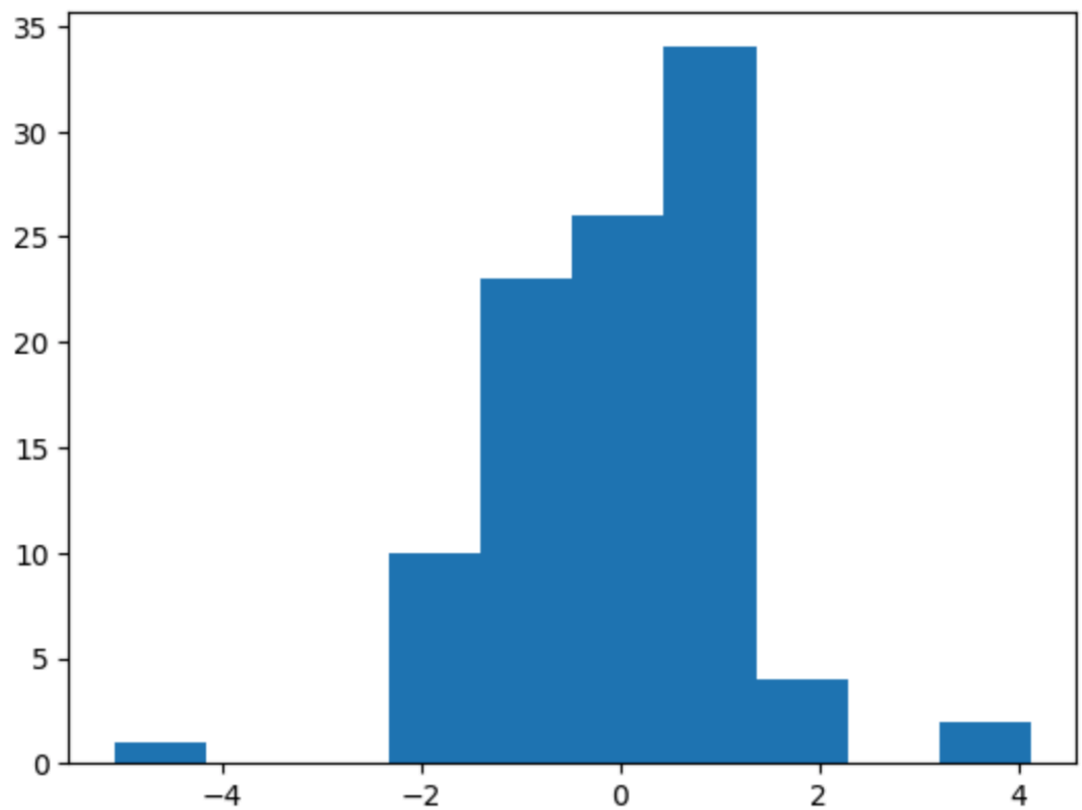
Part 1
At first, I used the function to calculate the OSL regression and below are the results of it.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.195
Model:                            OLS   Adj. R-squared:                  0.186
Method:                 Least Squares   F-statistic:                     23.68
Date:                Fri, 27 Jan 2023   Prob (F-statistic):           4.34e-06
Time:                        20:13:20   Log-Likelihood:                -159.99
No. Observations:                 100   AIC:                             324.0
Df Residuals:                      98   BIC:                             329.2
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.1198      0.121      0.990      0.325      -0.120       0.360
x              0.6052      0.124      4.867      0.000       0.358       0.852
==============================================================================
Omnibus:                       14.146   Durbin-Watson:                   1.885
Prob(Omnibus):                  0.001   Jarque-Bera (JB):               43.673
Skew:                          -0.267   Prob(JB):                     3.28e-10
Kurtosis:                       6.193   Cond. No.                         1.03
==============================================================================
```

Then I showed the value of these residuals respectively

```
0    -0.838485
1     0.835296
2     1.027428
3     1.319711
4    -0.152317
        ...
95   -1.590264
96   -1.694848
97    0.434878
98    0.402261
99   -0.922319
Length: 100, dtype: float64
```

After that, I plotted the histogram of residuals by using coding.



Based on three graphs above, I could conclude that the residuals are not normally distributed.

Part 2

For the normal distribution,

```
Mean: 0.059831751423101806
Standard deviation: 1.170052284824445
```

For the t distribution,

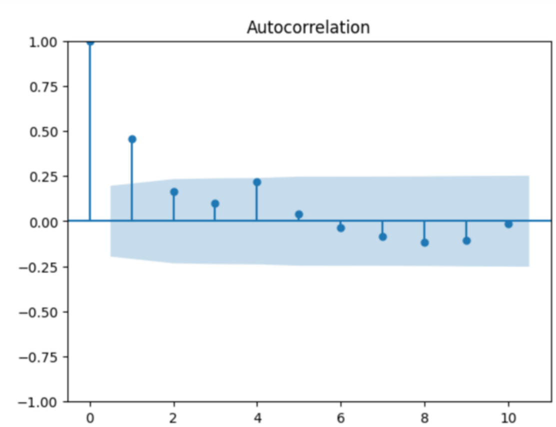
```
Mean: 0.059300888908623825
Standard deviation: 1.145293364939651
```

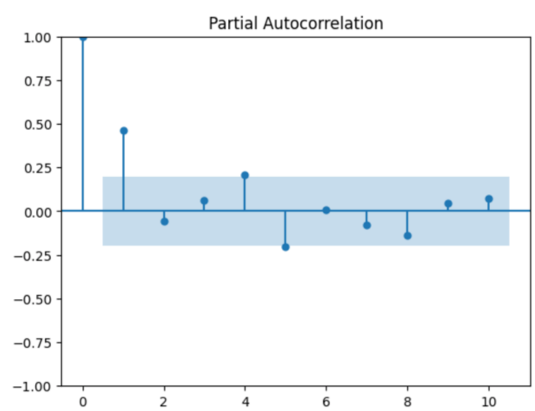
Since the parameters of t distributions is better, it fits better than the normal distribution.

Part3

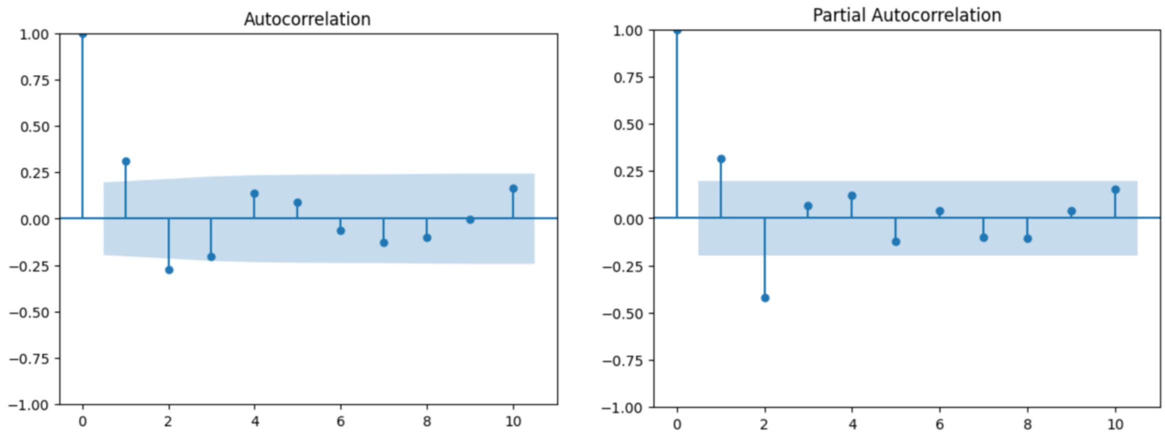
The mean of normal distribution is 0.059831751423101806
The standard deviation of normal distribution is 1.170052284824445
The mean of t distribution is 0.059300888908623825
The standard deviation of t distribution is 1.145293364939651
When the degrees of freedom is low, the t-distribution has heavier tails than a normal distribution, so the estimated location and scale parameters will be different. But as the degrees of freedom increases, the t-distribution approaches a normal distribution, and the estimated location and scale parameters will be closer to those of a normal distribution.

Problem 3
AR(1)

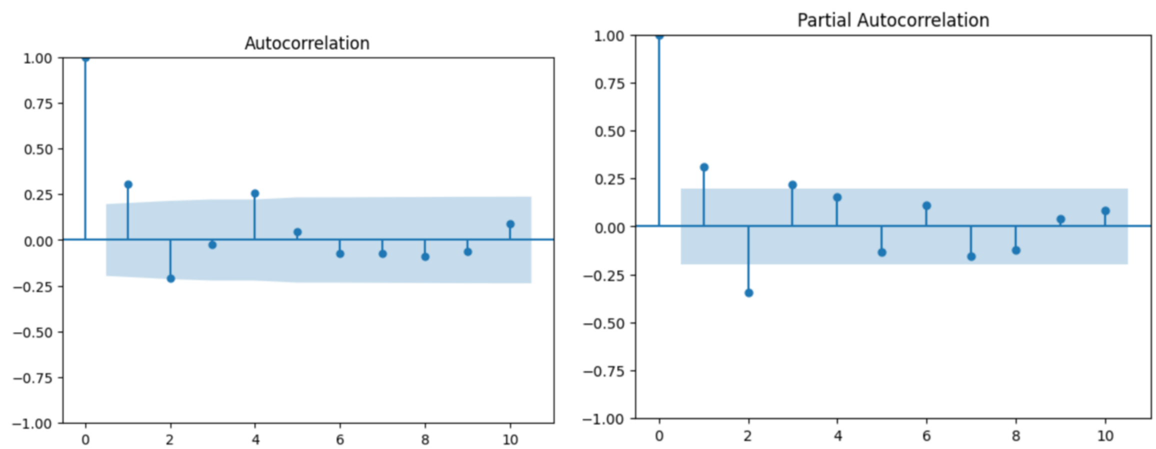




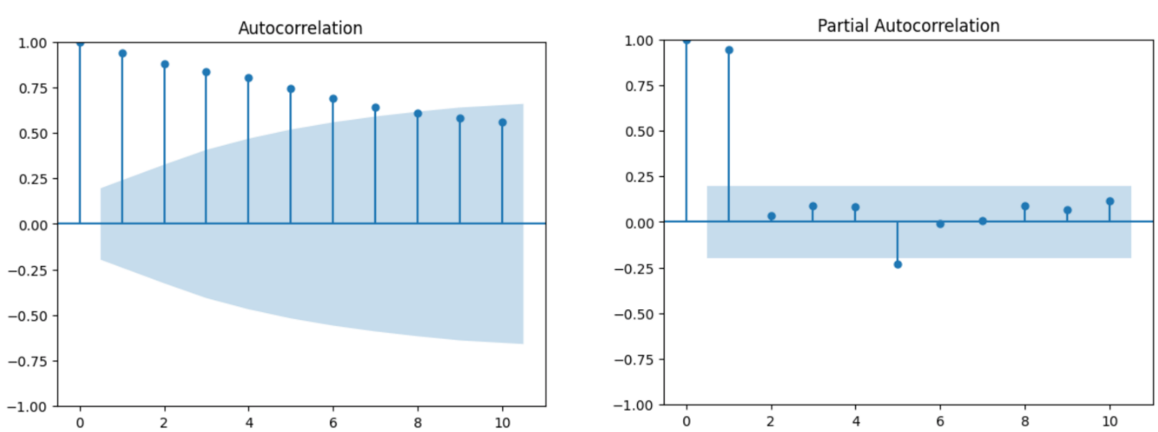
AR(2)


Autocorrelation
Partial Autocorrelation

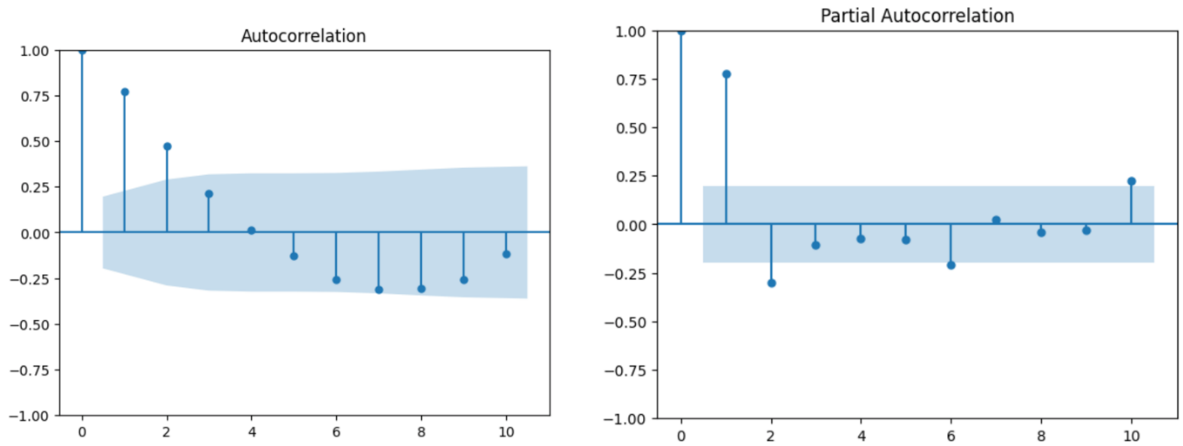
AR(3)


Autocorrelation
Partial Autocorrelation

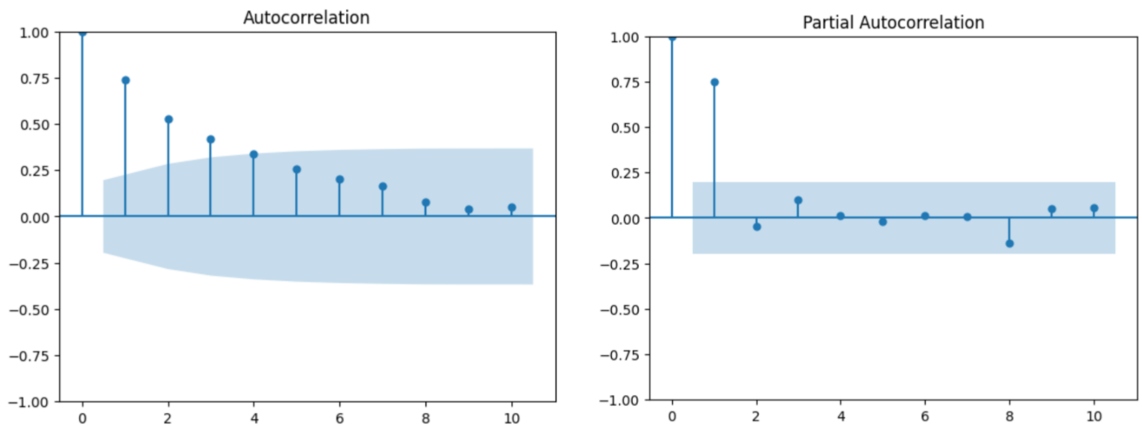
MA(1)


Autocorrelation
Partial Autocorrelation

MA(2)



MA(3)



We are able to use PACF and ACF graphs to identify the type and order of time series process. In AR model, both the ACF plot and PACF plot will have significant autocorrelations from AR(1) to AR(p), and the autocorrelation will decrease as tags increase.
And for the MA(p) process, the condition will be similar to the AR(p) process, whereas autocorrelation decreases as p increase.