<u>Analysis of AIRPASS.TSM</u>

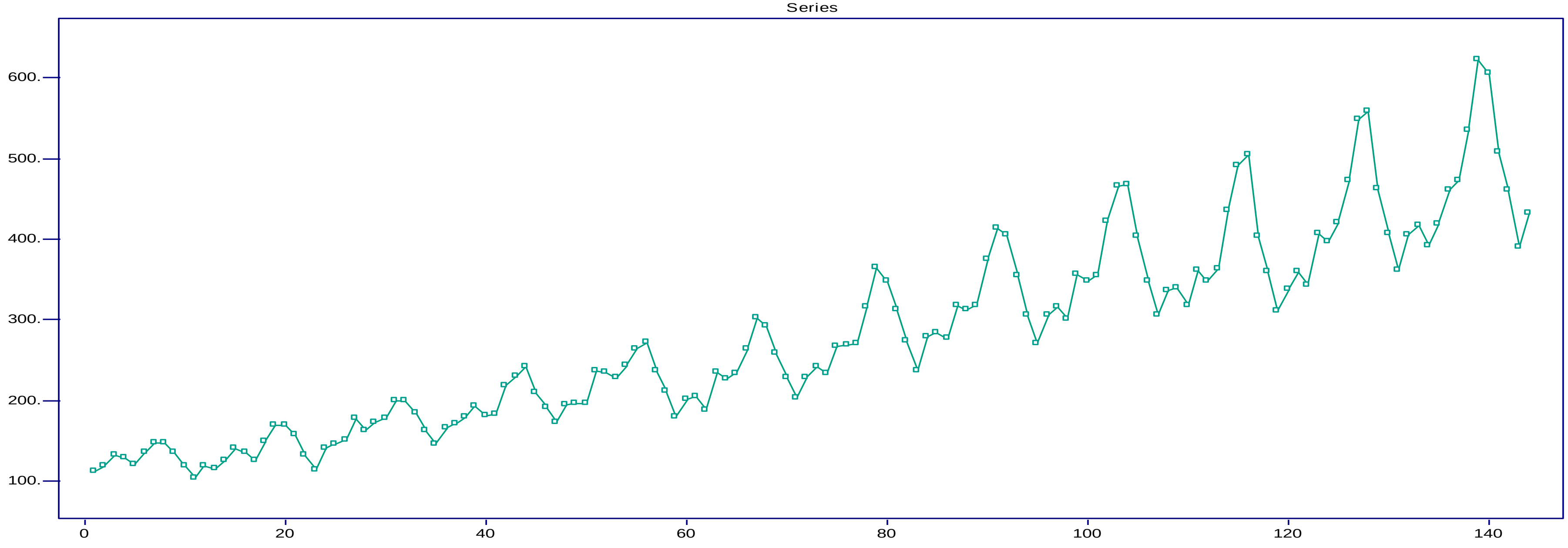
After opening ITSM software, to open existing file in ITSM, click on **File** ⇨ **Project** ⇨ **Open**

One dialog box will appear in that check either *Univariate* or *Multivariate*. In this case data set is univariate so click on,

Univariate ⇨ **OK** . One window will appear in that click on airpass.tsm and then click on **Open**

then following graph will appear in ITSM. The graph is of number of international airline passengers (in thousands) for each month from January,1949 to December,1960.

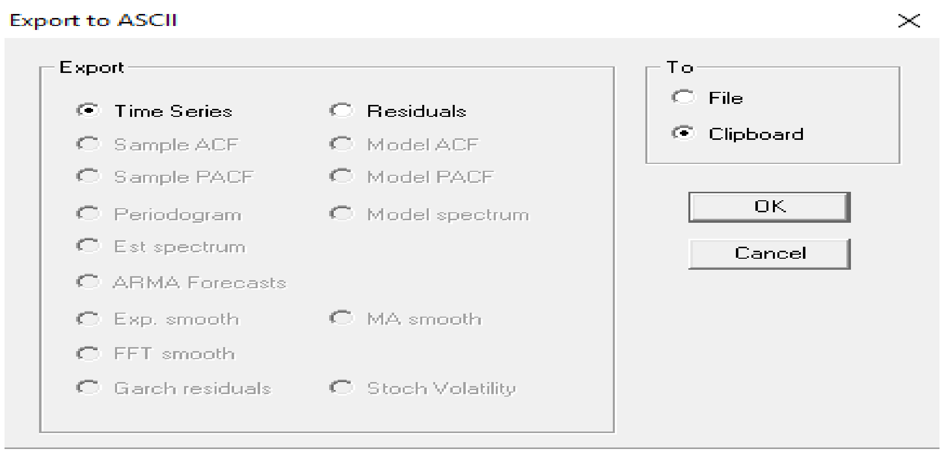
Graph:



To see a data of open file in ITSM, click on

File ⇨ **Export** ⇨ **Open**

Then one window will appear.



Click on,

Time Series ⇨ **Clipboard** ⇨ **OK**

Then go to *Ms-Word* or *Notepad* and paste.

Data: Number of international airline passengers (in thousands) for each month from January,1949 to December,1960.

Time(t)	X_t	Time(t)	X_t	Time(t)	X_t	Time(t)	X_t	Time(t)	X_t	Time(t)	X_t	Time(t)	X_t	Time(t)	X_t
1	112	21	158	41	183	61	204	81	312	101	355	121	360	141	508
2	118	22	133	42	218	62	188	82	274	102	422	122	342	142	461
3	132	23	114	43	230	63	235	83	237	103	465	123	406	143	390
4	129	24	140	44	242	64	227	84	278	104	467	124	396	144	432
5	121	25	145	45	209	65	234	85	284	105	404	125	420		
6	135	26	150	46	191	66	264	86	277	106	347	126	472		
7	148	27	178	47	172	67	302	87	317	107	305	127	548		
8	148	28	163	48	194	68	293	88	313	108	336	128	559		
9	136	29	172	49	196	69	259	89	318	109	340	129	463		
10	119	30	178	50	196	70	229	90	374	110	318	130	407		
11	104	31	199	51	236	71	203	91	413	111	362	131	362		
12	118	32	199	52	235	72	229	92	405	112	348	132	405		
13	115	33	184	53	229	73	242	93	355	113	363	133	417		
14	126	34	162	54	243	74	233	94	306	114	435	134	391		
15	141	35	146	55	264	75	267	95	271	115	491	135	419		
16	135	36	166	56	272	76	269	96	306	116	505	136	461		
17	125	37	171	57	237	77	270	97	315	117	404	137	472		
18	149	38	180	58	211	78	315	98	301	118	359	138	535		
19	170	39	193	59	180	79	364	99	356	119	310	139	622		
20	170	40	181	60	201	80	347	100	348	120	337	140	606		

If we press red **INFO** **button at the top of the ITSM then we will see:**

```
==========
ITSM::(INFO)
==========
# of Data Points =      144

Sample Mean = .2803E+03
Sample Variance = .142920E+05
Std.Error(Sample Mean) =  30.881007
(square root of (1/n)SUM{(1-|h|/r)acvf(h)}, |h|<r=[sqrt(n)])

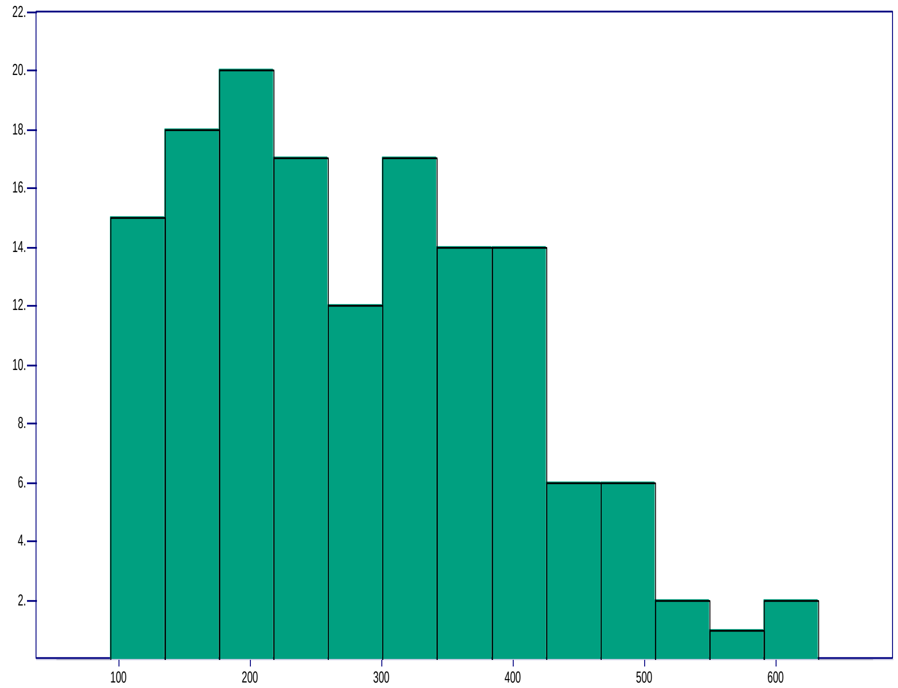
MODEL:
ARMA Model:
X(t) = Z(t)
WN Variance = 1.000000

Garch Model for Z(t):
Z(t) = sqrt(h(t)) e(t)
h(t) = 1.000000
{e(t)} is IID N(0,1)
```

Therefore, Sample Mean = 280.3
Sample Variance = 14292

To see the histogram press the **sixth yellow** **button:**

Histogram of AIRPASS.TSM:



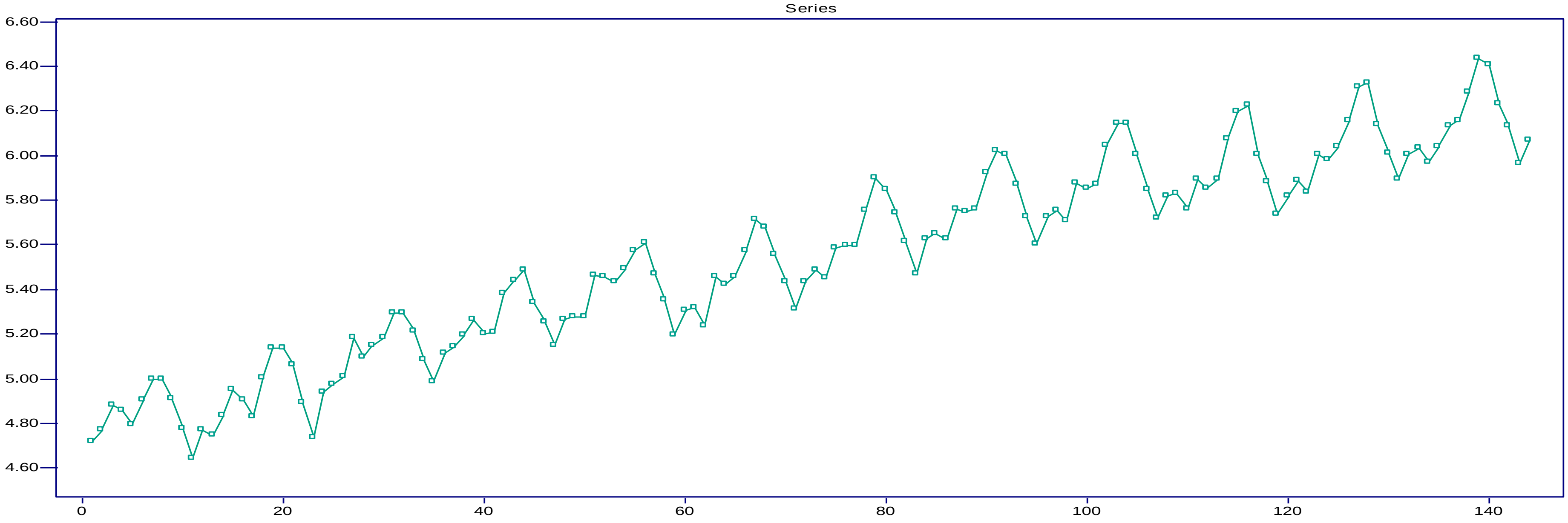
Transformation of data

By looking at graph we can decide that whether it required to transform or not. In general:

- If variation of the series increases over time then we can use Box-Cox Transformation. After transformation variation of the series must be same over time.
- If variation of the series not increases over time then no need to transform data.

Box-Cox transformation for AIRPASS.TSM:

Click on, Transform ⇨ Box-Cox , Enter parameter=0, then click on OK



We can see that after transformation variation of the series is same over time.

To eliminate trend and seasonality the method provided in ITSM:

Differencing: By looking at transformed data (original data if not transformed) check whether seasonality is there sometimes seasonality is of 12, 365 etc

- To remove a seasonal component of period 12 from the series $\{X_t\}$, we generate the transformed series

$$Y_t = X_t - X_{t-12}$$

All seasonal components of period 12 are eliminated by this transformation, which is called differencing at lag 12.

- To remove a seasonal component of period 365 from the series $\{X_t\}$, we generate the transformed series

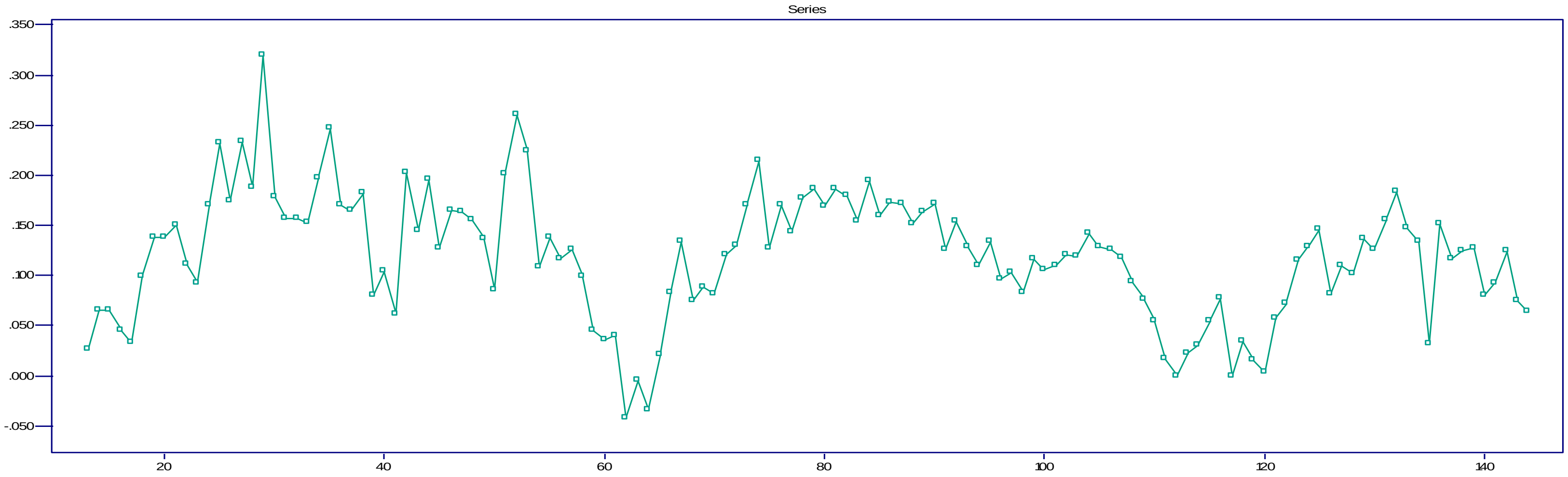
$$Y_t = X_t - X_{t-365}$$

All seasonal components of period 365 are eliminated by this transformation, which is called differencing at lag 365.

Differencing for AIRPASS.TSM:

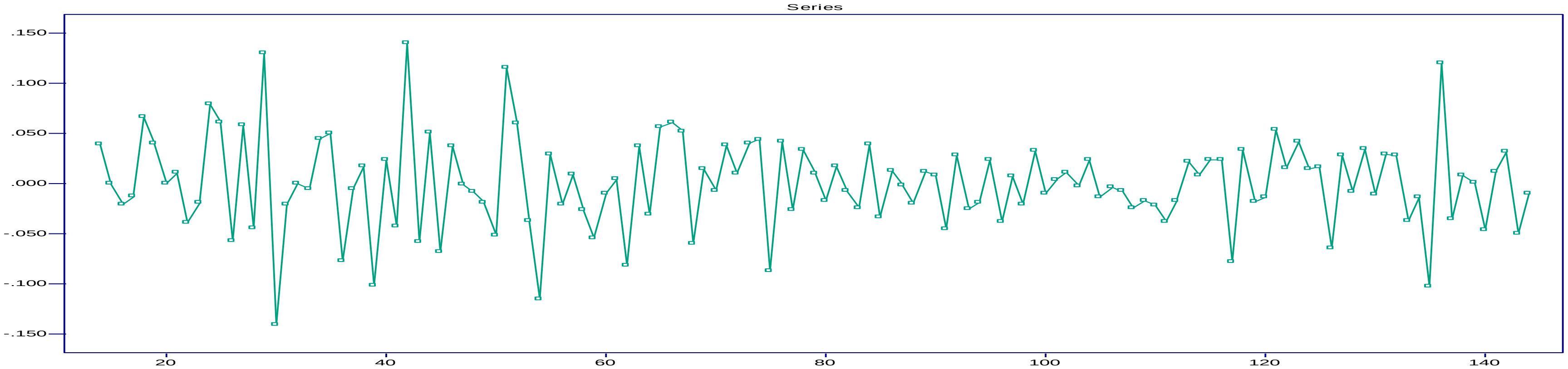
Consider a transformed AIRPASS.TSM in this seasonality is of 12 therefore click on: **Transform** ⇨ **Difference**

enter the lag 12 in dialog box then click on **OK**. Then following graph will appear



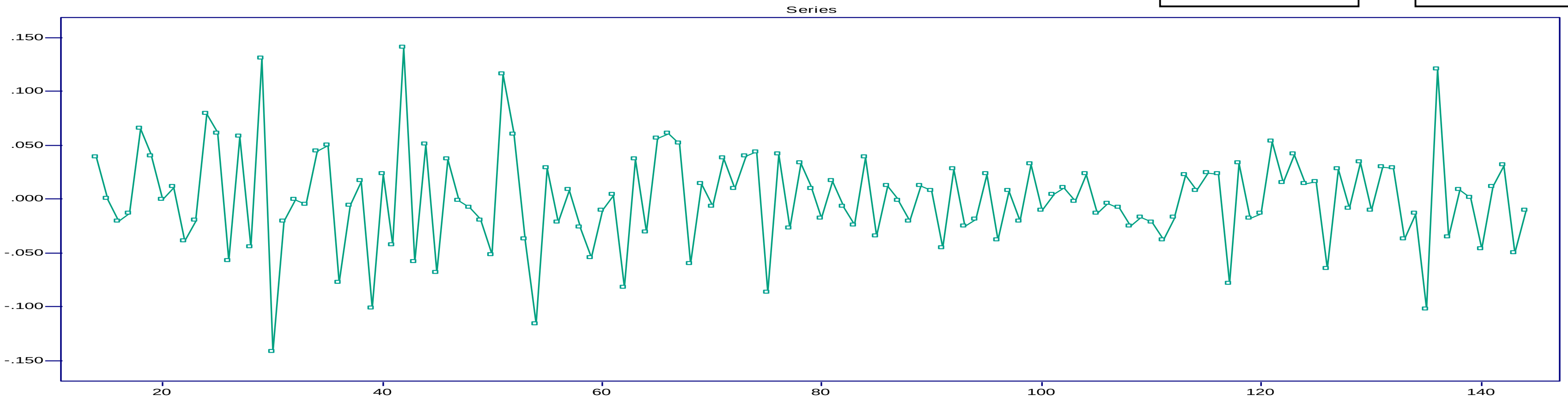
Inspection of the graph of the deseasonalized series suggests a further differencing at lag 1 to eliminate the remaining trend. To do this, repeat the previous step with lag equal to 1. (After removing a seasonality inspect graph and check whether trend is present or not. If trend is present then differencing at lag 1, continue this till trend has been removed)

The logged AIRPASS.TSM series after removal of trend and seasonal components by Differencing at lag 12 and lag 1:



Subtracting the Mean:

To subtract the mean of the transformed and twice-differenced series AIRPASS.TSM select, **Transform** ⇨ **Subtract Mean**



Finding a Model for Our data:

After removing of seasonality and trend as described above, we are now in a position to fit an ARMA model to stationary time series.

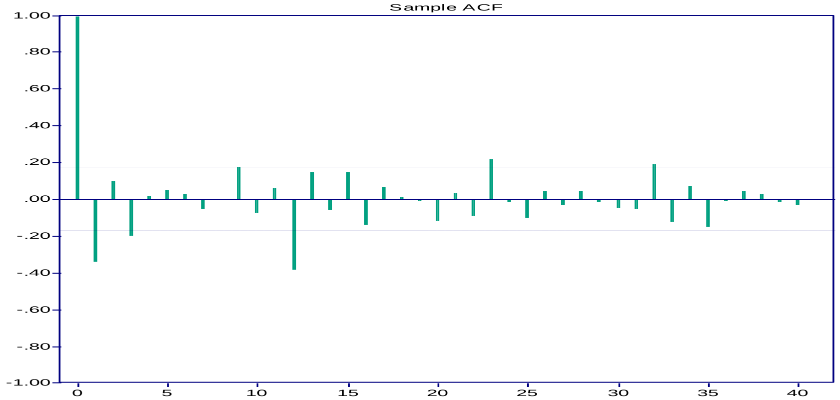
The sample ACF and PACF:

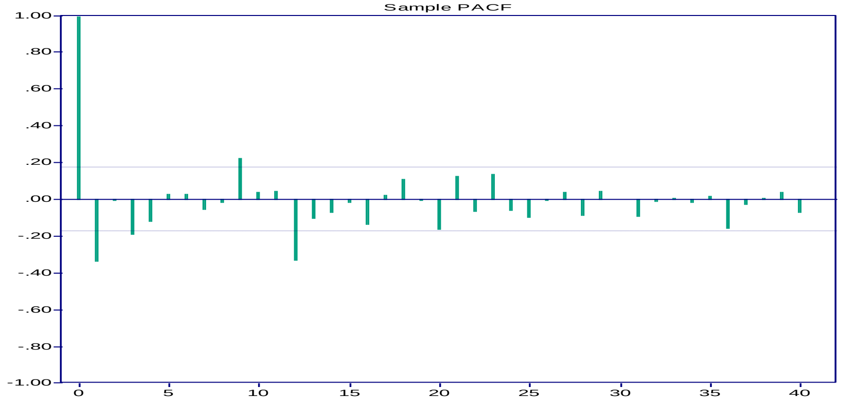
Clicking the **second yellow** button at the top of the ITSM window will produce graphs of the sample ACF and PACF for the values of the lag h from 1 up to 40.

For higher lags choose **Statistics** ⇨ **ACF/PACF** ⇨ **Specify Lag**, enter the maximum lag required and click on **OK**. If we want separate graphs of Sample ACF and Sample PACF then again click repeatedly **second yellow** button.

The sample ACF:

- Values of the sample ACF that decay rapidly as h increases indicate short-term dependency in the time series while slowly decaying values indicate long-term dependency.
- To fit ARMA model it is desirable to have a sample ACF that decays very rapidly.
- The sample ACF that is positive and very slowly decaying suggests that the data may have a trend so transformed data before continuing.
- The sample ACF with very slowly damped periodicity suggests the presence of a periodic seasonal component



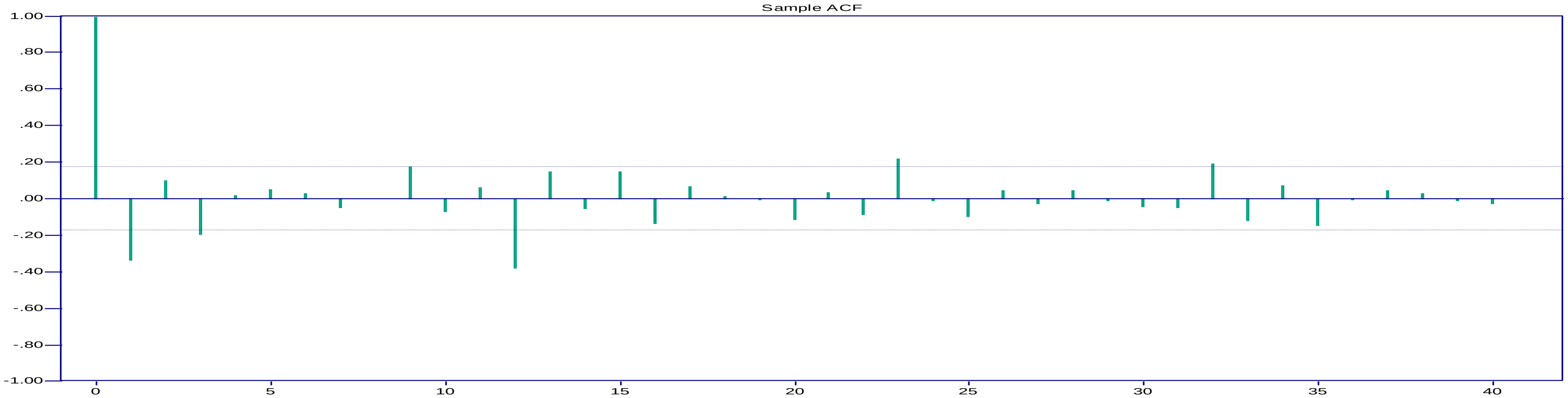


To obtain numerical values of the sample ACF and PACF, right click on the graph and select **Info** .

```
===============
ITSM::(ACF/PACF)
===============
# of Lags =      40
Sample Autocorrelations:
Sample Variance = .00208602
     1.0000     -.3411     .1050     -.2021     .0214
     .0557      .0308     -.0556     -.0008     .1764
     -.0764     .0644     -.3866     .1516      -.0576
     .1496      -.1389    .0705      .0156      -.0106
     -.1167     .0386     -.0914     .2233      -.0184
     -.1003     .0486     -.0302     .0471      -.0180
     -.0511     -.0538    .1957      -.1224     .0777
     -.1525     -.0100    .0469      .0312      -.0151
Sample Partial Autocorrelations:
     1.0000     -.3411    -.0128     -.1927     -.1250
     .0331      .0347     -.0602     -.0202     .2256
     .0431      .0466     -.3387     -.1092     -.0768
     -.0218     -.1395    .0259      .1148      -.0132
     -.1674     .1324     -.0720     .1429      -.0673
     -.1027     -.0101    .0438      -.0900     .0469
     -.0049     -.0964    -.0153     .0115      -.0192
     .0230      -.1649    -.0340     .0087      .0451
```

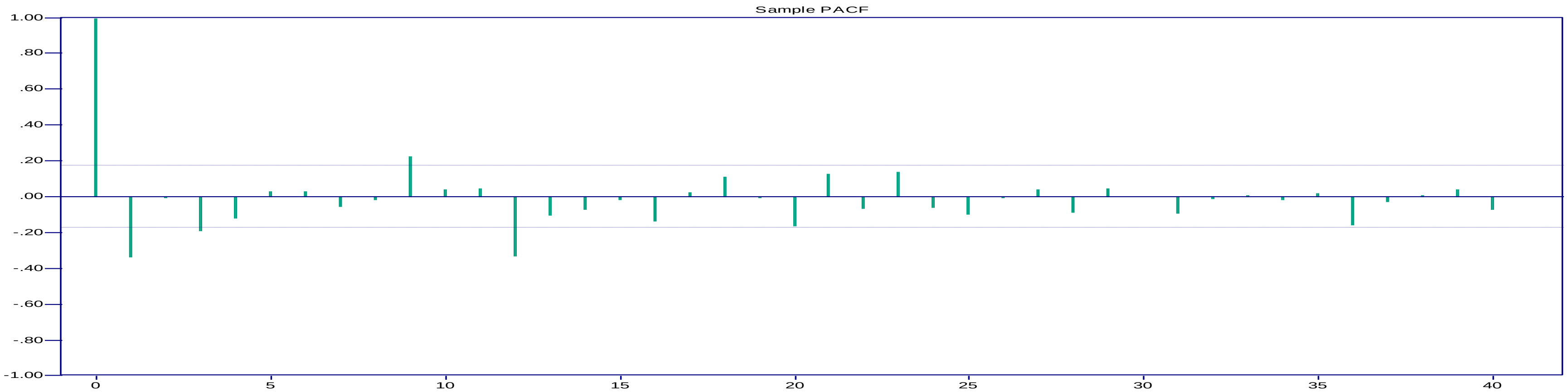
The graph of the sample ACF and PACF sometimes suggest an appropriate ARMA model for the data. Roughly, if the sample ACF falls between the plotted bounds $\pm 1.96/\sqrt{n}$ for lags h>q, then an MA(q) model is suggested, while if the sample PACF falls between the plotted points $\pm 1.96/\sqrt{n}$ for lags h>p, then AR(p) model is suggested.

Graph of Sample ACF for AIRPASS.TSM after taking logarithms, differencing at lags 12 and 1:



The graph suggests that we can consider an MA model of order 12 (or order 23).

Graph of Sample PACF for AIRPASS.TSM after taking logarithms, differencing at lags 12 and 1:



The graph suggests that we can consider an AR model of order 12.

<u>Fitting of Model for Stationary Time Series</u>

To fit Model for transformed and differenced stationary time series first obtain preliminary estimators, click on **Model** ⇨ **Estimation** ⇨ **Preliminary** one window will appear. To fit AR model there are two methods *Yule -Walker Estimates* and *Burg Estimates* and to fit MA or ARMA model there are two methods *Hannan-Rissanen Algorithm* and *Innovations Algorithm*.

- ITSM provides a choice between preliminary estimation methods:

i. To fit pure AR(p) model (i.e. q=0) use *Burg Estimates*. Also click on *Find AR model with min AICC* (This allow the program to fit AR model of orders 0, 1, 2, …, 27 and select the one with minimum AICC value).

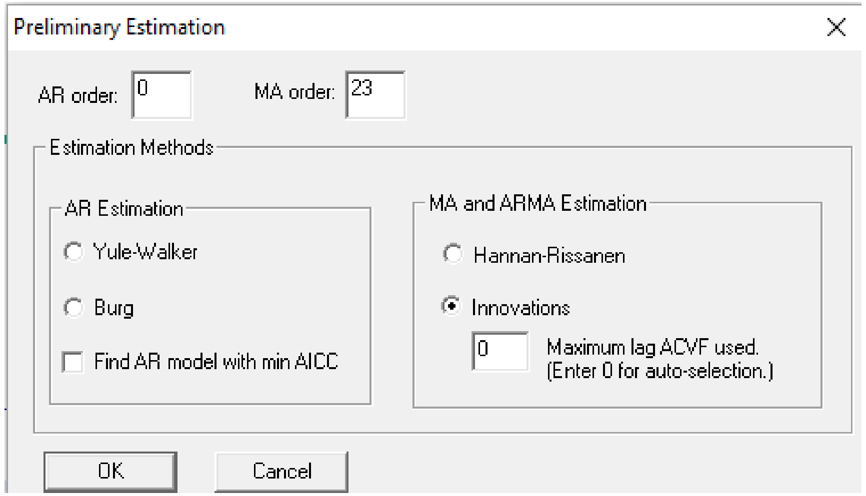
ii. To fit ARMA(p, q) model (both p and q greater than 0) use *Hannan-Rissanen Algorithm*.

iii. To fit pure MA(q) model (i.e. p=0) use *Innovations Algorithm*. In this enter *Maximum lag ACVF used* as 0.

<u>To fit MA(23) Model for AIRPASS.TSM</u>: Sample ACF suggests MA(23) Model, to fit MA(23) Model for transformed and differenced stationary time series click on,

Model ⇨ **Estimation** ⇨ **Preliminary**

one window will appear. Enter *MA order* as 23 and click on *Innovations* also enter *Maximum lag ACVF used* as 0.



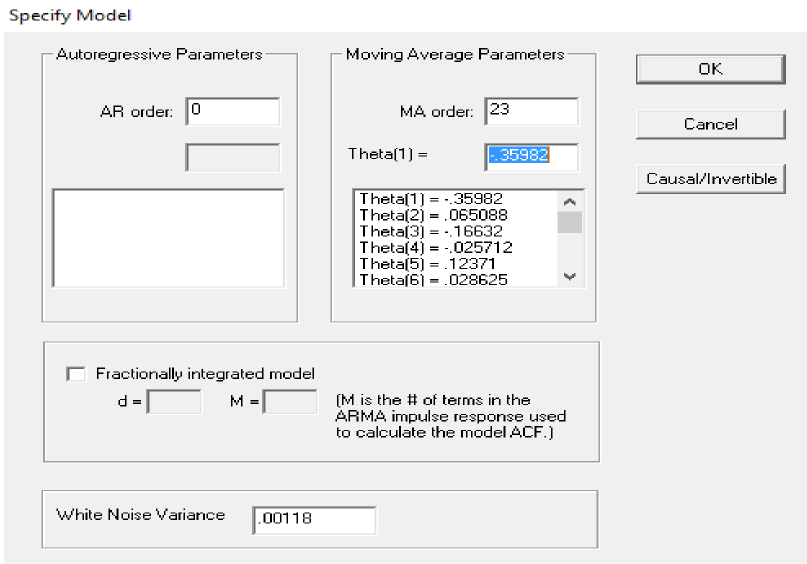
ITSM gives following preliminary estimates:

```
===================================
ITSM::(Preliminary estimates)
===================================
Method: Innovations
(Maximum lag ACVF used is 38.)
ARMA Model:
X(t) = Z(t) - .3598 Z(t-1) + .06509 Z(t-2) - .1663 Z(t-3)
   - .02571 Z(t-4) + .1237 Z(t-5) + .02863 Z(t-6) + .02642 Z(t-7)
   - .06969 Z(t-8) + .1396 Z(t-9) - .07251 Z(t-10) - .01660 Z(t-11)
   - .4879 Z(t-12) + .1757 Z(t-13) - .03578 Z(t-14) + .1482 Z(t-15)
   - .1376 Z(t-16) + .03703 Z(t-17) - .01842 Z(t-18) - .08089 Z(t-19)
   - .03871 Z(t-20) - .01724 Z(t-21) - .01201 Z(t-22) + .1975 Z(t-23)
WN Variance = .001178
MA Coefficients
    -.359819    .065088   -.166318   -.025712
     .123708    .028625    .026421   -.069688
     .139606   -.072513   -.016605   -.487893
     .175707   -.035780    .148151   -.137553
     .037027   -.018420   -.080893   -.038706
    -.017235   -.012011    .197520
Ratio of MA coeff. to 1.96 * (standard error)
   -2.101181    .357639   -.912156   -.139326
     .670146    .154057    .142146   -.374810
     .749310   -.386037   -.088207  -2.591431
     .853037   -.171883    .711395   -.655657
     .175391   -.087211   -.382962   -.182849
    -.081380   -.056706    .932496
(Residual SS)/N = .00117832
WN variance estimate (Innovations): .00120004
-2Log(Like) = -.505142E+03
AICC = -.445822E+03
```

Our aim is to find model with minimum AICC. Here in preliminary estimators AICC is -445.822. To find model with minimum AICC do the following procedure:

Looking at values of *Ratio of MA (or AR) coeff. to 1.96 * (standard error)* , the absolute values which are < 0.9 corresponding MA (or AR) Coefficients set as 0. Here for lags 1, 3, 12 & 23 the absolute values of *Ratio of MA coeff. to 1.96 * (standard error)* > 0.9 therefore set all other lags MA coefficients as 0 except lags 1, 3, 12 & 23.

To set some coefficients in the current model as zero click on **Model** ⇨ **Specify** then one window will appear:

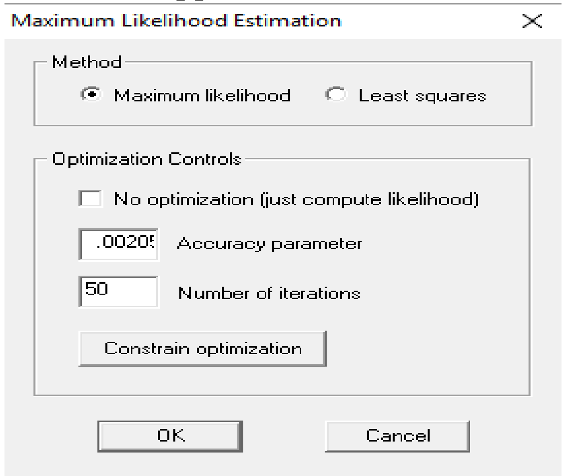


Set all other MA coefficients as 0 except Theta(1), Theta(3), Theta(12) & Theta(23) and then click on **OK**

Once setting some coefficients to zero then click on

Model ⇨ **Estimation** ⇨ **Max likeihood**

one window will appear



Click on Maximum likelihood and then on **OK**

ITSM gives following Maximum likelihood estimates:

```
========================================
ITSM::(Maximum likelihood estimates)
========================================
Method: Maximum Likelihood
ARMA Model:
X(t) = Z(t) - .3547 Z(t-1) + .0000 Z(t-2) - .2013 Z(t-3)
    + .0000 Z(t-4) + .0000 Z(t-5) + .0000 Z(t-6) + .0000 Z(t-7)
    + .0000 Z(t-8) + .0000 Z(t-9) + .0000 Z(t-10) + .0000 Z(t-11)
    - .5235 Z(t-12) + .0000 Z(t-13) + .0000 Z(t-14) + .0000 Z(t-15)
    + .0000 Z(t-16) + .0000 Z(t-17) + .0000 Z(t-18) + .0000 Z(t-19)
    + .0000 Z(t-20) + .0000 Z(t-21) + .0000 Z(t-22) + .2413 Z(t-23)
WN Variance = .001250
MA Coefficients
     -.354657     .000000    -.201297     .000000
      .000000     .000000     .000000     .000000
      .000000     .000000     .000000    -.523508
      .000000     .000000     .000000     .000000
      .000000     .000000     .000000     .000000
      .000000     .000000     .241307
Standard Error of MA Coefficients
      .059395     .000000     .059316     .000000
      .000000     .000000     .000000     .000000
      .000000     .000000     .000000     .058037
      .000000     .000000     .000000     .000000
      .000000     .000000     .000000     .000000
      .000000     .000000     .055851
(Residual SS)/N = .00125021
AICC = -.486037E+03
BIC  = -.487617E+03
-2Log(Likelihood) = -.496517E+03
Accuracy parameter = .00205000
Number of iterations = 5
Number of function evaluations = 46
```

The value of AICC is -486.03 which is minimum than preliminary estimators AICC value.
Therefore the MA(23) model for this data is,

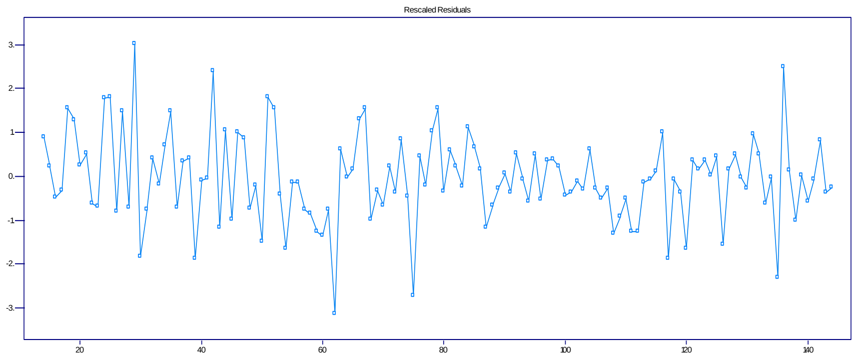
$$X_t = Z_t - 0.3547\, Z_{t-1} - 0\,.2013 Z_{t-3} - 0.5235 Z_{t-12} + 0.2413 Z_{t-23}$$

To check fitted Model is good or not:

ITSM provides a number of tests for checking fitted model is good or not.

Plot: This is the graph of estimated R_t vs. t, If the fitted model is appropriate then 95% of the rescaled residuals lie between ±1.96. If more than 5% of the rescaled residuals lie outside ±1.96 then fitted model is inappropriate. To obtain the graph of rescaled residuals click on

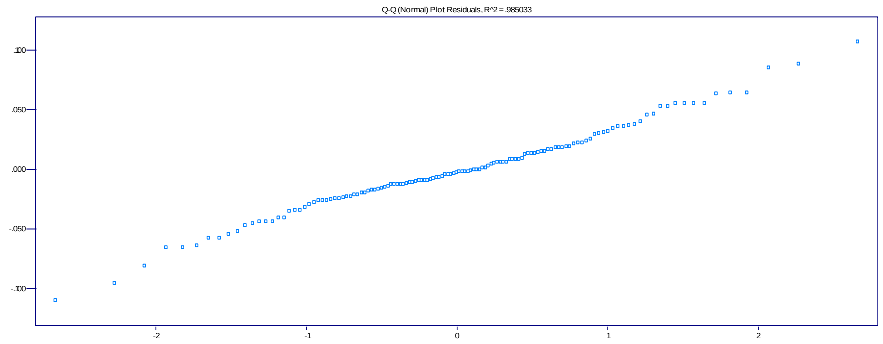
Statistic ⇨ **Residual Analysis** ⇨ **Plot**



Here approximately out of 140 values 6 values lie outside the ±1.96. Therefore fitted model is good.

QQ-Plot(Normal): If QQ-Plot is straight line then fitted model is good. To obtain QQ-Plot Click on

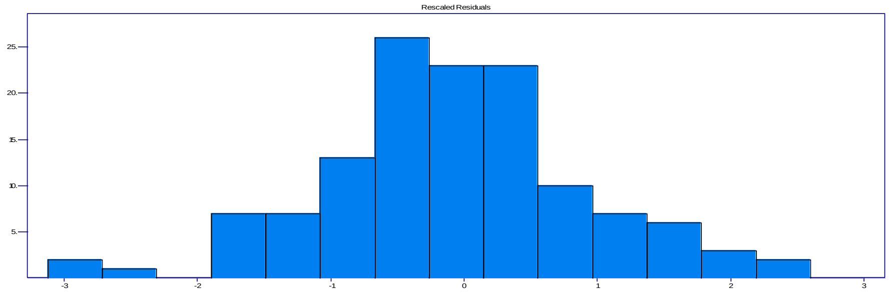
Statistics ⇨ **Residual Analysis** ⇨ **QQ Plot(Normal)**



Here QQ Plot(Normal) is straight line therefore fitted model is good.

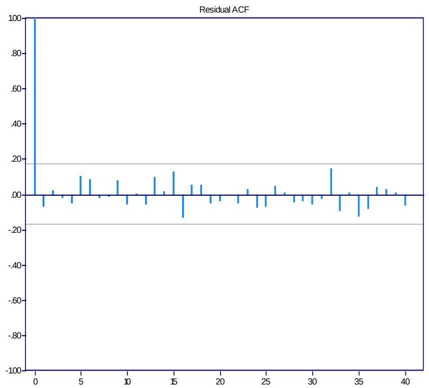
Histogram:If fitted model is appropriate then histogram of the rescaled residuals should have mean close to zero shape is like normal distribution. To obtain Histogram click on

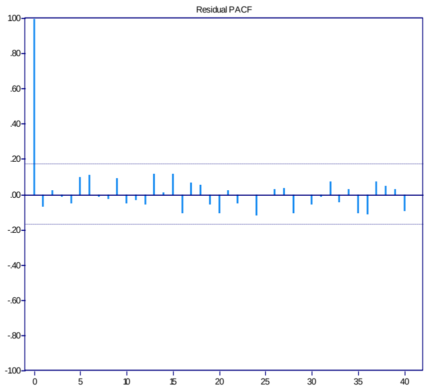
Statistics ⇨ **Residual Analysis** ⇨ **Histogram** ⇨ **Default**



The maen of this graph is close to zero and shape is also like normal distribution therefore the fitted model is good.

ACF/PACF: Roughly if 95% of the sample ACF and PACF of the observed residuals are lie between the bounds $\pm1.96/\sqrt{n}$ then fitted model is good otherwise look for another better model.





Here all the values of ACF and PACF of the observed residuals are lie between the bounds $\pm1.96/\sqrt{n}$ therefore fitted model is good.

Tests of Randomness: There are six tests available in ITSM to check the randomness of the residuals. The null hypothesis H_0 is,

H_0 : The residuals are obseved values of iid r.v's

v/s

H_1 : The residuals are not observed values of iid r.v's.

If H_0 is accepted (i.e. if p-value >0.05) by most of the tests then our work will be done. To obtain result of this six tests click on

Statistic ⇨ **Residual Analysis** ⇨ **Tests of Randomness**

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ITSM::(Tests of randomness on residuals)

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Ljung - Box statistic = 16.491 Chi-Square (20), p-value = .68574

McLeod - Li statistic = 14.499 Chi-Square (24), p-value = .93456

Turning points = 87.000~AN(86.000,sd = 4.7924), p-value = .83471

Diff sign points = 64.000~AN(65.000,sd = 3.3166), p-value =.76302

Rank test statistic = .39670E+04~AN(.42575E+04,sd = .25130E+03), p-value = .24769

Jarque-Bera test statistic (for normality) = 3.9839 Chi-Square (2), p-value = .13643

Order of Min AICC YW Model for Residuals = 0

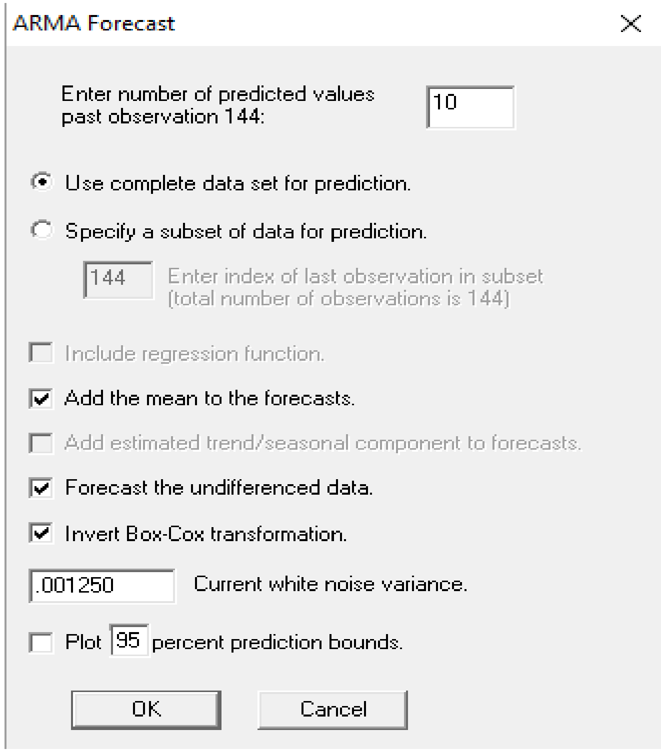
Here all p-values are >0.05 therefore accept H_0 at 5% level of significance. Therefore residuals are observed values of iid r.v's.

Overall conclusion is MA(23) model is good fitted to this data. The model is

$$\boxed{X_t = Z_t - 0.3547\, Z_{t-1} - 0\,.2013 Z_{t-3} - 0.5235 Z_{t-12} + 0.2413 Z_{t-23}}$$

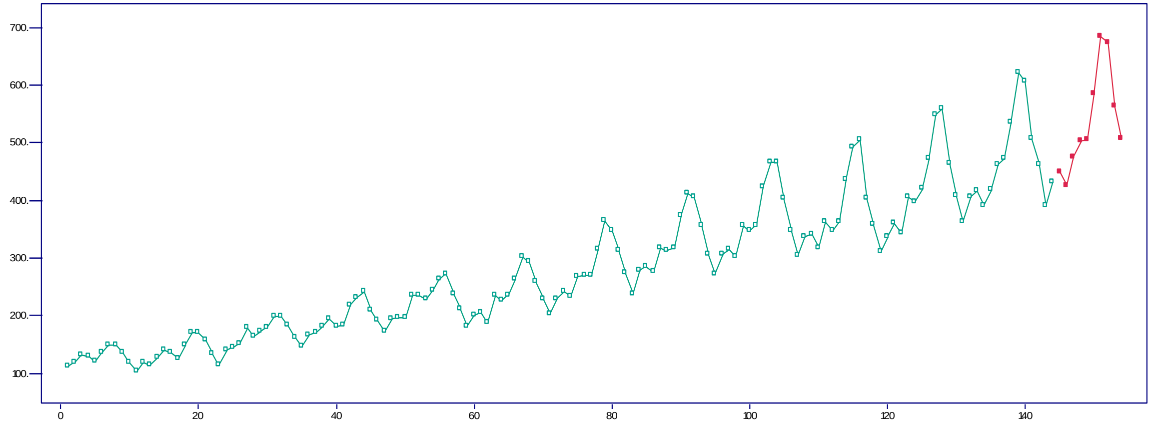
Forecasting:

To forecast original series, in ITSM click on **Forecasting** ⇨ **ARMA** then one window will appear



In this Enter number of predicted values, by default number of predicted values are 10. Assuming the MA(23) as a fitted model to the data ITSM gives forecast. The red line indicates forecasted values.

Forecasting of 10 values:



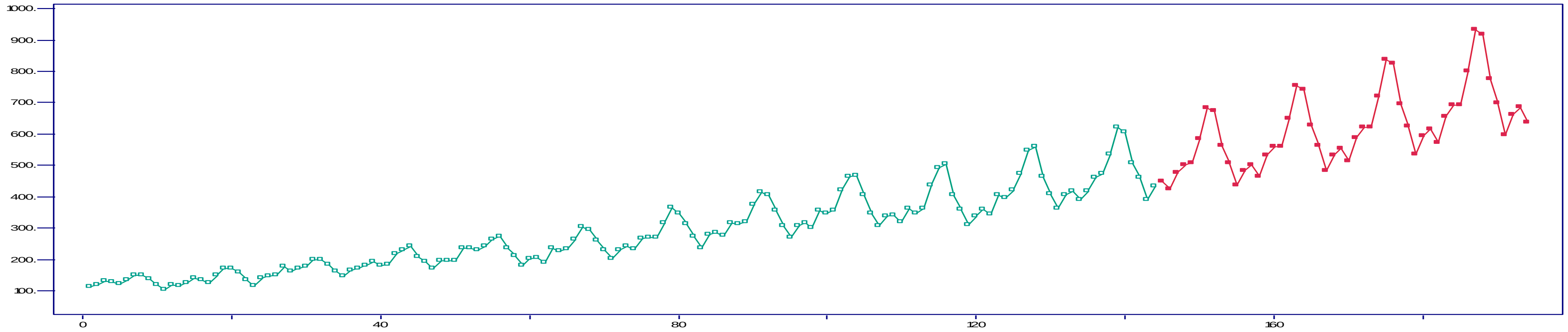
To obtain numerical values of forecasts then right click on graph and then click on Info

```
====================
ITSM::(ARMA Forecast)
====================
                    Approximate 95 Percent
                      Prediction Bounds
 Step    Prediction      Lower        Upper
   1    .44950E+03    .41941E+03    .48176E+03
   2    .42416E+03    .39058E+03    .46062E+03
   3    .47548E+03    .43290E+03    .52225E+03
   4    .50164E+03    .45447E+03    .55369E+03
   5    .50584E+03    .45614E+03    .56095E+03
   6    .58514E+03    .52529E+03    .65180E+03
   7    .68325E+03    .61073E+03    .76438E+03
   8    .67280E+03    .59891E+03    .75581E+03
   9    .56351E+03    .49962E+03    .63557E+03
  10    .50798E+03    .44864E+03    .57516E+03
```

Therefore the 10 forecasted values are:

Forecast value no.	Forecasted value
1	449.50
2	424.16
3	475.48
4	501.64
5	505.84
6	585.14
7	683.25
8	672.80
9	563.51
10	507.98

<u>Forecasting of 50 values</u>:



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ITSM::(ARMA Forecast)
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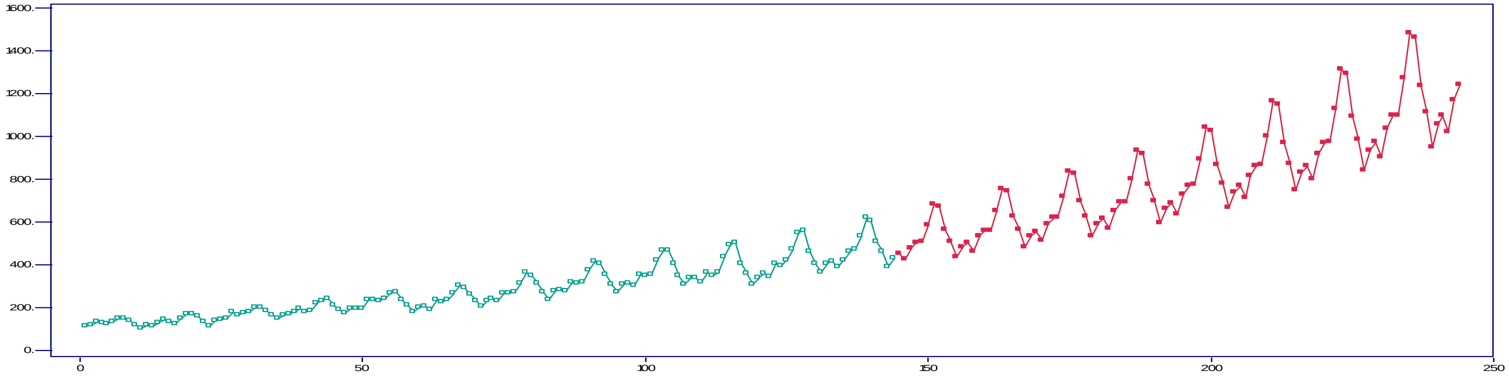
Approximate 95 Percent Prediction Bounds

Step	Prediction	Lower	Upper
1	.44950E+03	.41941E+03	.48176E+03
2	.42416E+03	.39058E+03	.46062E+03
3	.47548E+03	.43290E+03	.52225E+03
4	.50164E+03	.45447E+03	.55369E+03
5	.50584E+03	.45614E+03	.56095E+03
6	.58514E+03	.52529E+03	.65180E+03
7	.68325E+03	.61073E+03	.76438E+03
8	.67280E+03	.59891E+03	.75581E+03
9	.56351E+03	.49962E+03	.63557E+03
10	.50798E+03	.44864E+03	.57516E+03
11	.43455E+03	.38236E+03	.49388E+03
12	.48118E+03	.42184E+03	.54887E+03
13	.50073E+03	.43260E+03	.57960E+03
14	.46339E+03	.39828E+03	.53915E+03
15	.53081E+03	.45395E+03	.62068E+03
16	.56079E+03	.47862E+03	.65708E+03
17	.56079E+03	.47766E+03	.65838E+03
18	.64895E+03	.55166E+03	.76339E+03
19	.75432E+03	.63998E+03	.88908E+03
20	.74260E+03	.62883E+03	.87697E+03
21	.62651E+03	.52951E+03	.74128E+03
22	.56322E+03	.47512E+03	.66766E+03
23	.48092E+03	.40494E+03	.57116E+03
24	.53268E+03	.44626E+03	.63583E+03
25	.55449E+03	.45751E+03	.67202E+03
26	.51329E+03	.42077E+03	.62615E+03
27	.58813E+03	.47909E+03	.72198E+03
28	.62154E+03	.50468E+03	.76545E+03
29	.62171E+03	.50322E+03	.76810E+03
30	.71966E+03	.58068E+03	.89189E+03
31	.83675E+03	.67309E+03	.10402E+04
32	.82400E+03	.66082E+03	.10275E+04
33	.69538E+03	.55601E+03	.86969E+03
34	.62532E+03	.49851E+03	.78438E+03
35	.53410E+03	.42455E+03	.67192E+03
36	.59175E+03	.46753E+03	.74898E+03
37	.61616E+03	.47943E+03	.79188E+03
38	.57054E+03	.44063E+03	.73875E+03
39	.65392E+03	.50138E+03	.85288E+03
40	.69127E+03	.52777E+03	.90542E+03
41	.69166E+03	.52587E+03	.90973E+03
42	.80086E+03	.60638E+03	.10577E+04
43	.93144E+03	.70240E+03	.12352E+04
44	.91751E+03	.68913E+03	.12216E+04
45	.77452E+03	.57944E+03	.10353E+04
46	.69669E+03	.51919E+03	.93487E+03
47	.59523E+03	.44188E+03	.80181E+03
48	.65967E+03	.48636E+03	.89475E+03
49	.68708E+03	.49893E+03	.94619E+03
50	.63640E+03	.45836E+03	.88361E+03

Forecasting of 100 values:



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ITSM::(ARMA Forecast)
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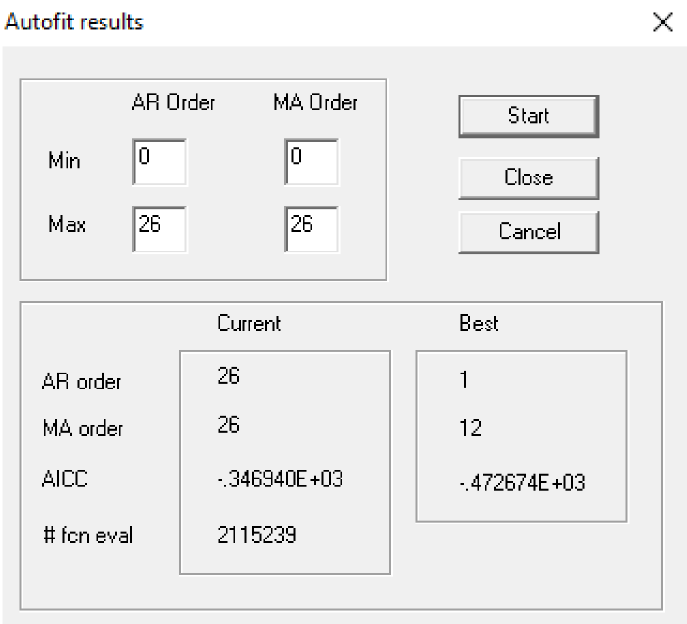
Approximate 95 Percent
Prediction Bounds

Step	Prediction	Lower	Upper
1	.44950E+03	.41941E+03	.48176E+03
2	.42416E+03	.39058E+03	.46062E+03
3	.47548E+03	.43290E+03	.52225E+03
4	.50164E+03	.45447E+03	.55369E+03
5	.50584E+03	.45614E+03	.56095E+03
6	.58514E+03	.52529E+03	.65180E+03
7	.68325E+03	.61073E+03	.76438E+03
8	.67280E+03	.59891E+03	.75581E+03
9	.56351E+03	.49962E+03	.63557E+03
10	.50798E+03	.44864E+03	.57516E+03
11	.43455E+03	.38236E+03	.49388E+03
12	.48118E+03	.42184E+03	.54887E+03
13	.50073E+03	.43260E+03	.57960E+03
14	.46339E+03	.39828E+03	.53915E+03
15	.53081E+03	.45395E+03	.62068E+03
16	.56079E+03	.47862E+03	.65708E+03
17	.56079E+03	.47766E+03	.65838E+03
18	.64895E+03	.55166E+03	.76339E+03
19	.75432E+03	.63998E+03	.88908E+03
20	.74260E+03	.62883E+03	.87697E+03
21	.62651E+03	.52951E+03	.74128E+03
22	.56322E+03	.47512E+03	.66766E+03
23	.48092E+03	.40494E+03	.57116E+03
24	.53268E+03	.44626E+03	.63583E+03
25	.55449E+03	.45751E+03	.67202E+03
26	.51329E+03	.42077E+03	.62615E+03
27	.58813E+03	.47909E+03	.72198E+03
28	.62154E+03	.50468E+03	.76545E+03
29	.62171E+03	.50322E+03	.76810E+03
30	.71966E+03	.58068E+03	.89189E+03
31	.83675E+03	.67309E+03	.10402E+04
32	.82400E+03	.66082E+03	.10275E+04
33	.69538E+03	.55601E+03	.86969E+03
34	.62532E+03	.49851E+03	.78438E+03
35	.53410E+03	.42455E+03	.67192E+03
36	.59175E+03	.46753E+03	.74898E+03
37	.61616E+03	.47943E+03	.79188E+03
38	.57054E+03	.44063E+03	.73875E+03
39	.65392E+03	.50138E+03	.85288E+03
40	.69127E+03	.52777E+03	.90542E+03
41	.69166E+03	.52587E+03	.90973E+03
42	.80086E+03	.60638E+03	.10577E+04
43	.93144E+03	.70240E+03	.12352E+04
44	.91751E+03	.68913E+03	.12216E+04
45	.77452E+03	.57944E+03	.10353E+04
46	.69669E+03	.51919E+03	.93487E+03
47	.59523E+03	.44188E+03	.80181E+03
48	.65967E+03	.48636E+03	.89475E+03
49	.68708E+03	.49893E+03	.94619E+03
50	.63640E+03	.45836E+03	.88361E+03
51	.72962E+03	.52131E+03	.10212E+04
52	.77151E+03	.54843E+03	.10853E+04
53	.77218E+03	.54614E+03	.10918E+04
54	.89434E+03	.62941E+03	.12708E+04
55	.10405E+04	.72866E+03	.14857E+04
56	.10252E+04	.71451E+03	.14710E+04
57	.86568E+03	.60046E+03	.12481E+04
58	.77892E+03	.53773E+03	.11283E+04
59	.66568E+03	.45743E+03	.96875E+03
60	.73796E+03	.50328E+03	.10821E+04
61	.76885E+03	.51648E+03	.11445E+04
62	.71234E+03	.47433E+03	.10698E+04
63	.81692E+03	.53931E+03	.12374E+04
64	.86408E+03	.56710E+03	.13166E+04
65	.86508E+03	.56447E+03	.13258E+04
66	.10022E+04	.65024E+03	.15448E+04
67	.11663E+04	.75244E+03	.18079E+04
68	.11496E+04	.73749E+03	.17918E+04
69	.97096E+03	.61950E+03	.15218E+04
70	.87390E+03	.55455E+03	.13772E+04
71	.74707E+03	.47153E+03	.11836E+04
72	.82843E+03	.51865E+03	.13232E+04
73	.86335E+03	.53241E+03	.14000E+04
74	.80014E+03	.48886E+03	.13096E+04
75	.91787E+03	.55570E+03	.15161E+04
76	.97114E+03	.58411E+03	.16146E+04
77	.97254E+03	.58118E+03	.16274E+04
78	.11271E+04	.66924E+03	.18981E+04
79	.13120E+04	.77414E+03	.22235E+04
80	.12935E+04	.75848E+03	.22059E+04
81	.10929E+04	.63690E+03	.18752E+04
82	.98389E+03	.56991E+03	.16986E+04
83	.84135E+03	.48442E+03	.14613E+04
84	.93324E+03	.53271E+03	.16349E+04
85	.97287E+03	.54699E+03	.17303E+04
86	.90189E+03	.50216E+03	.16198E+04
87	.10349E+04	.57071E+03	.18767E+04
88	.10953E+04	.59970E+03	.20004E+04
89	.10972E+04	.59650E+03	.20181E+04
90	.12719E+04	.68667E+03	.23558E+04
91	.14810E+04	.79406E+03	.27622E+04
92	.14605E+04	.77776E+03	.27427E+04
93	.12343E+04	.65288E+03	.23337E+04
94	.11116E+04	.58404E+03	.21157E+04
95	.95083E+03	.49627E+03	.18217E+04
96	.10550E+04	.54564E+03	.20398E+04
97	.11001E+04	.56040E+03	.21596E+04
98	.10201E+04	.51440E+03	.20231E+04
99	.11709E+04	.58453E+03	.23456E+04
100	.12396E+04	.61406E+03	.25024E+04

Autofit in ITSM: ITSM provides facility of Autofit. To find model by using Autofit click on

Model ⇨ **Estimation** ⇨ **Preliminary**

then one window will appear. Enter maximum order of ARMA(p, q) and click on **Start** ITSM starts searching the model which has minimum AICC by taking all the combinations and give a model with minimum AICC.

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========================================
ITSM::(Maximum likelihood estimates)
========================================
Method: Maximum Likelihood
ARMA Model:
X(t) = - .3173 X(t-1)
    + Z(t) - .02943 Z(t-1) - .03337 Z(t-2) - .1377 Z(t-3)
    - .2733 Z(t-4) + .1043 Z(t-5) + .06834 Z(t-6) - .05938 Z(t-7)
    - .01740 Z(t-8) + .04558 Z(t-9) + .007903 Z(t-10) + .1470 Z(t-11)
    - .6807 Z(t-12)
WN Variance = .001134
AR Coefficients
    -.317267
Standard Error of AR Coefficients
     .114662
MA Coefficients
    -.029427    -.033372    -.137742    -.273317
     .104307     .068344    -.059375    -.017405
     .045582     .007903     .147012    -.680654
Standard Error of MA Coefficients
     .086556     .063501     .062823     .064956
     .074050     .070451     .069061     .068149
     .068339     .062842     .062803     .065780
(Residual SS)/N = .00113375
AICC = -.472674E+03
BIC  = -.476612E+03
-2Log(Likelihood) = -.504294E+03
Accuracy parameter = .100000E-08
Number of iterations = 1
Number of function evaluations = 2115239
Uncertain minimum.
```

The AICC value by autofit is -472.674. The AICC value of MA(23) model is -486.03. Therefore the best model is MA(23) which we had find out.