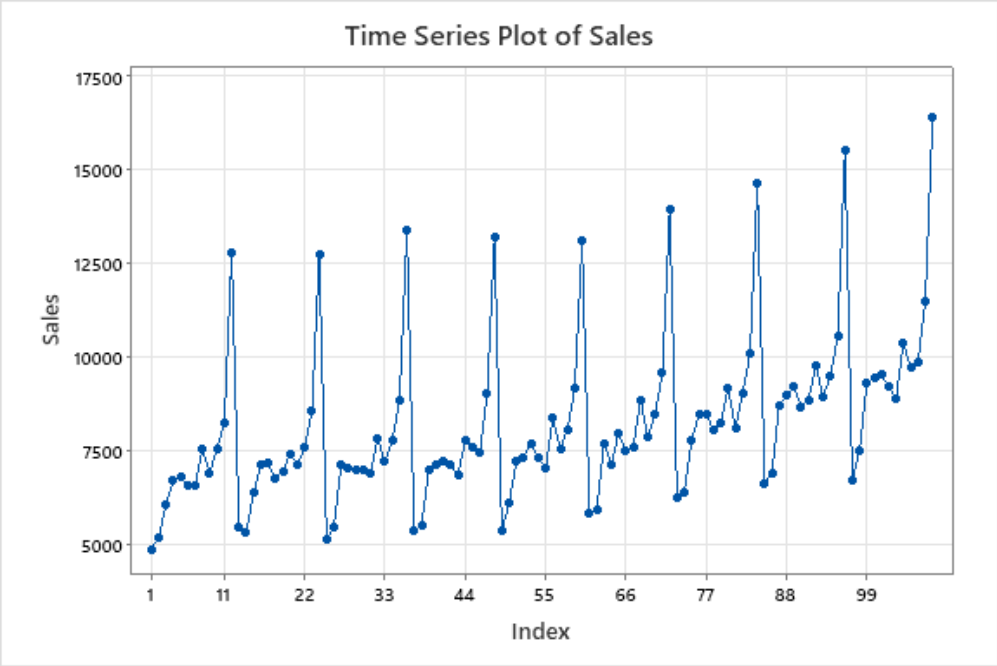
212137

STAT 3124
Quiz 1
212137

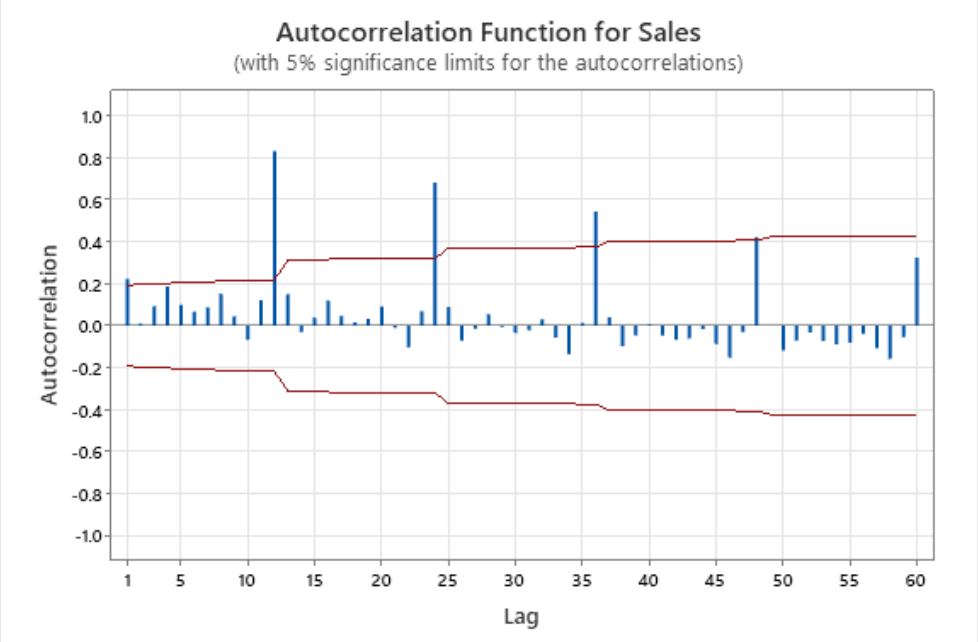
1)

a. Time series plot



b. This time series plot exhibits a seasonal pattern with an upward trend.

c. Autocorrelation Function



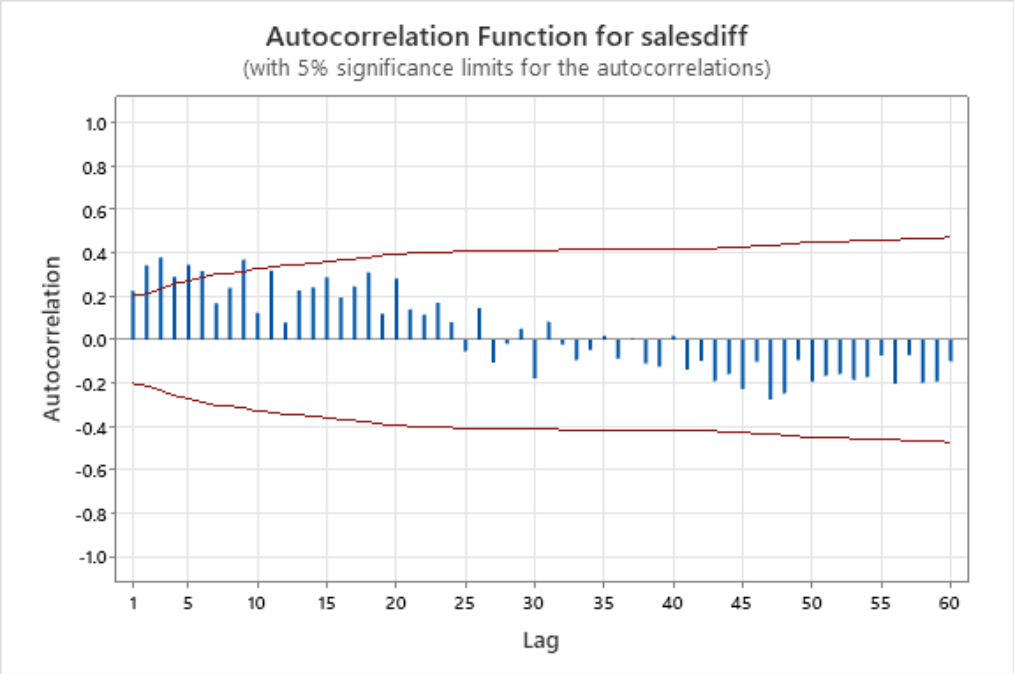
Autocorrelations

Lag	ACF	T	LBQ
1	0.224179	2.33	5.58
2	0.011058	0.11	5.59
3	0.092695	0.92	6.57
4	0.185805	1.83	10.51
5	0.099326	0.95	11.65
6	0.067212	0.64	12.17
7	0.086796	0.82	13.06
8	0.152932	1.43	15.84
9	0.044287	0.41	16.07
10	-0.067845	-0.62	16.63
11	0.121508	1.11	18.44
12	0.831281	7.52	103.95
24	0.682681	4.21	178.58
36	0.543957	2.88	233.68
48	0.421836	2.05	279.19
60	0.324552	1.50	323.46

ACF cuts off at lag 1 in non-seasonal area and ACF cuts off at lag 4 in seasonal area.
Therefore, this series is non-stationary.

d. ACF Cuts off at non-seasonal lag 1 and ACF cuts off at seasonal lag 4. In seasonal area it is a slowly dies down pattern.
Therefore, this series is non-stationary.
We have to do a seasonal difference to convert this series into stationary.

e. Seasonal Difference

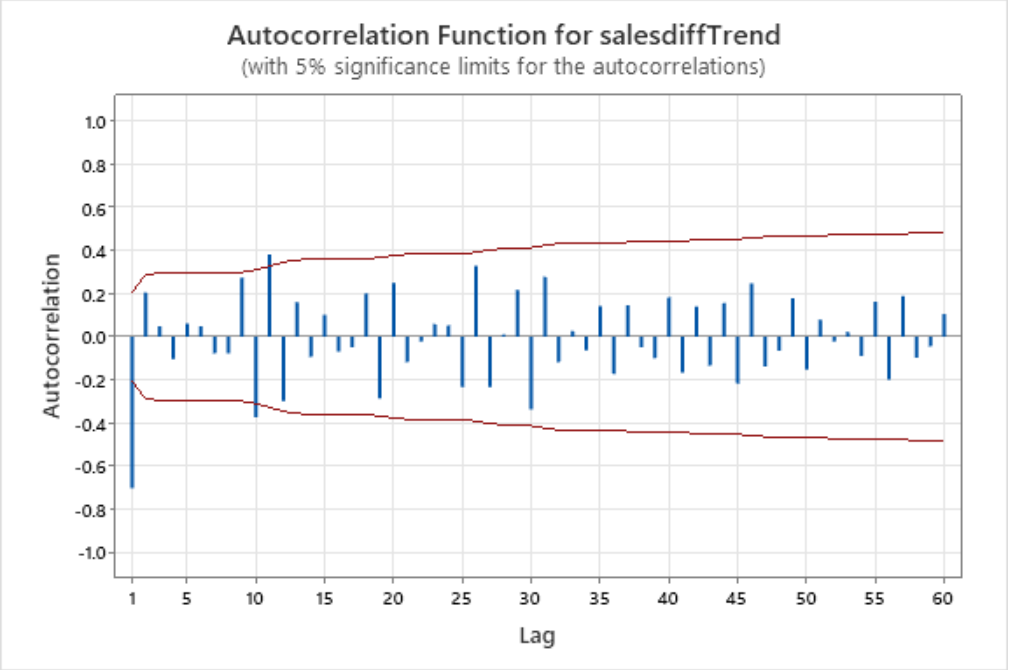


Autocorrelations

Lag	ACF	T	LBQ
1	0.225433	2.21	5.03
2	0.342243	3.19	16.76
3	0.379609	3.22	31.33
4	0.289741	2.23	39.92
5	0.344255	2.52	52.17
6	0.316794	2.18	62.66
7	0.168239	1.10	65.65
8	0.239054	1.55	71.76
9	0.370205	2.34	86.58
10	0.123834	0.74	88.26
11	0.318828	1.90	99.51
12	0.078582	0.45	100.20
24	0.080351	0.39	166.11
36	-0.087838	-0.42	179.81
48	-0.247308	-1.11	238.40
60	-0.099170	-0.42	306.83

There is a slowly dies down pattern in non-seasonal area.
Therefore, this series is non-stationary.
We have to do a trend difference to convert this series into stationary series.

Trend Difference



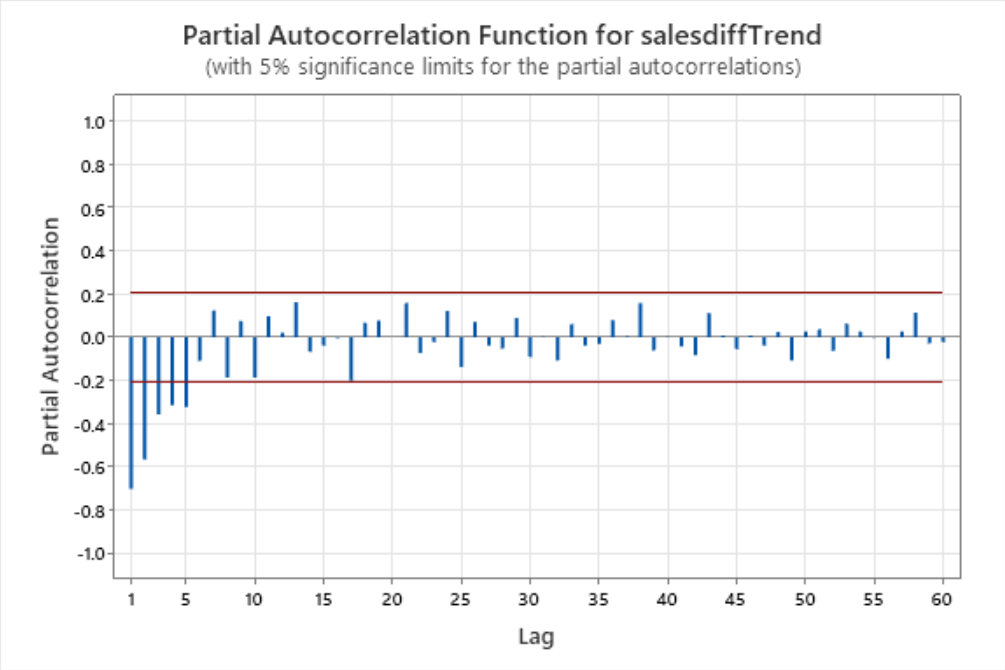
Autocorrelations

Lag	ACF	T	LBQ
1	-0.701880	-6.80	47.80
2	0.205454	1.41	51.94
3	0.048109	0.32	52.17
4	-0.103466	-0.70	53.24
5	0.061590	0.41	53.63
6	0.047930	0.32	53.87
7	-0.076535	-0.51	54.47
8	-0.076962	-0.51	55.09
9	0.274547	1.82	63.10
10	-0.372630	-2.39	78.01
11	0.380738	2.31	93.77
12	-0.298435	-1.71	103.58
24	0.051828	0.27	134.20
36	-0.173278	-0.79	206.99
48	-0.064183	-0.27	258.31
60	0.106454	0.44	303.06

ACF cuts off at non-seasonal lag 1 and other significant values in non-seasonal area, we can consider these values as spike values.

Therefore, this series is stationary.

f. .



	Partial Autocorrelations	
Lag	PACF	T
1	-0.701880	-6.80
2	-0.566028	-5.49
3	-0.357727	-3.47
4	-0.315445	-3.06
5	-0.323551	-3.14
6	-0.109703	-1.06
7	0.124568	1.21
8	-0.186622	-1.81
9	0.075105	0.73
10	-0.185933	-1.80
11	0.097970	0.95
12	0.019924	0.19
24	0.120823	1.17
36	0.079547	0.77
48	0.023461	0.23
60	-0.022646	-0.22

PACF cuts of at non-seasonal lag 5.

g. Tentative model

p = cuts off lag value in PACF in non-seasonal = 0
d = no. of trend differences = 1
q = cuts off lag value in ACF in non-seasonal = 1
P = cuts off lag value in PACF in seasonal = 0
D = no. of seasonal differences = 1
Q = cuts off lag value in ACF in seasonal = 0
S = seasonal length = 12

Tentative model
SARIMA $(0,1,1)(0,1,0)_{12}$

h. Final Estimates of Parameters

Type	Coef	SE CoeF	T-Value	P-Value
MA 1	0.9207	0.0398	23.14	0.000
Constant	4.74	2.40	1.98	0.051

Significance of the parameters,
H_0 : all coefficient = 0
H_1 : all coefficient ≠ 0

p- values < 0.05
Therefore, null hypothesis is rejected.
Therefore, we do not have to revised the model.

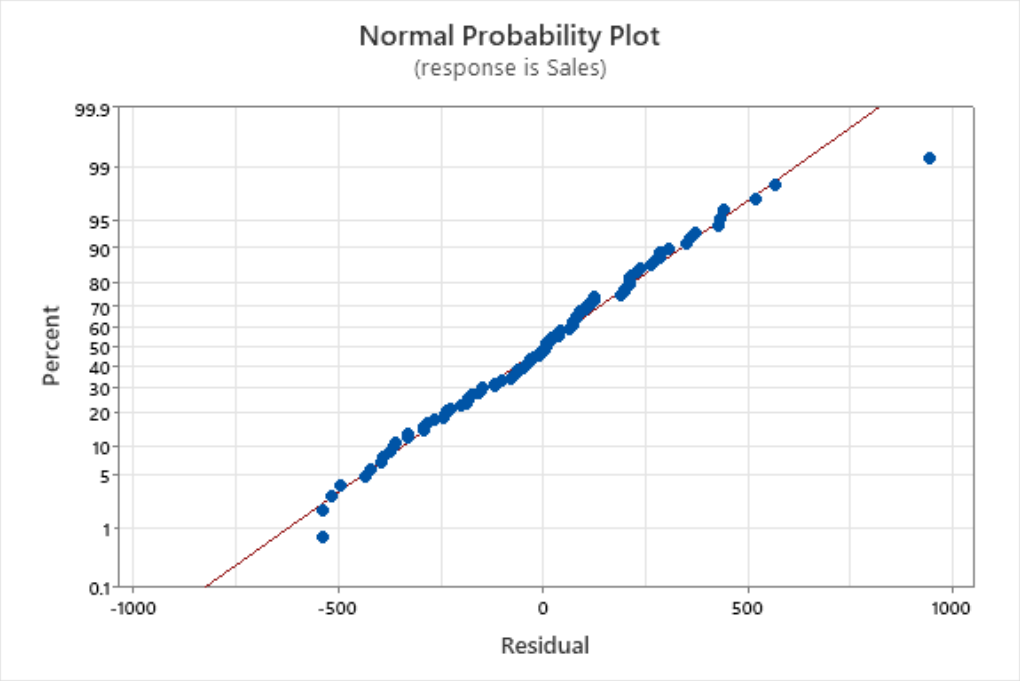
i. Randomness of the residuals

Modified Box-Pierce (Ljung-Box) Chi-Square Statistic

Lag	12	24	36	48
Chi-Square	22.09	36.67	71.39	100.47
DF	10	22	34	46
P-Value	0.015	0.026	0.000	0.000

j. .

k. Normality of the residuals



l. Final model for the dataset.
SARIMA $(0,1,1)(0,1,0)_{12}$