Seasonal Component Analysis

SESSION 17

Structure

17.1 INTRODUCTION

Prerequisite

- Lab Sessions 15 and 16 of MSTL-002 (Industrial Statistics Lab).
- Unit 14 of MSTE-002 (Industrial Statistics-II).

In Lab Session 15, you have learnt the method for estimating the trend using the curve fitting method. You have also learnt the methods for smoothing or filtering the time series, i.e., the simple moving average, weighted moving average and exponential smoothing methods in Lab Session 16.

When time series data reflect seasonal variation, we estimate the seasonal component by removing the irregular component. In this lab session, you will learn three methods of estimating seasonal indices, i.e., the simple average method, ratio to trend method and ratio to moving average method.

If the effect of seasonal variation is not removed from the time series data containing the trend effect, the trend estimates are affected by the seasonal effects. Therefore, we have to deseasonalise the data by dividing the given time series data by the corresponding seasonal indices. Once the data is free from the seasonal effect, we estimate the trend components. For estimation of the trend components from the deseasonalised data, we apply the method of least squares as explained in Lab Session 15.

Objectives

After performing the activities of this session, you should be able to:

- prepare the spreadsheet in MS Excel 2007;
- obtain the seasonal indices using simple average, ratio to trend and moving average methods;
- determine the deseasonalised values; and
- compare the original and deseasonalised values graphically.

17.2 PROBLEM DESCRIPTION

For this lab session, we consider the data given in Lab Session 16 and apply the simple average, ratio to trend and moving average methods to

- compute the seasonal indices for 12 months,
- obtain the deseasonalised values and estimate the trend line by the method of least squares, and
- plot the given data and the deseasonalised values.

17.3 SIMPLE AVERAGE METHOD

The simple average method is the simplest method of measuring seasonality. This method is used to estimate the seasonal effect from the given time series data. It is based on the assumption that the given data do not contain any trend and cyclic components. This method consists of elimination of the irregular component by averaging the monthly (or quarterly, weekly or yearly) values over the years. It consists of the following steps:

The assumptions of no trend and cyclic components may or may not be true since most economic or business time series data exhibit trend.

Step 1: We arrange the data by months, quarters or weeks, etc., if monthly, quarterly or weekly data are given. For example, if we have monthly data, we arrange the data according to the months in rows and years in columns.

Step 2: After arranging the time series data, we calculate the averages (monthly, quarterly or weekly). For example, if we have monthly data, we calculate the average for each month for one year, i.e., $\bar{y}_i$ for $(i = 1, 2, ..., 12)$.

Step 3: We calculate the grand average of these averages. For example, if we have monthly data for one year, the grand average is

$$\bar{\bar{y}} = \frac{\bar{y}_1 + \bar{y}_2 + ... + \bar{y}_{12}}{12} \qquad ...(1)$$

Step 4: We express each average as the percentage of the grand average $\bar{\bar{y}}$. These percentages are known as **seasonal indices**. For example, if we have monthly data, the seasonal index for the i^{th} month is given by

$$S_i = \frac{\bar{y}_i}{\bar{\bar{y}}} \times 100, \qquad \text{for } i = 1, 2, ..., 12. \qquad ...(2)$$

Step 5: To adjust seasonality of the data, we can also obtain the deseasonalised values by dividing the original (given) values with its corresponding adjusted seasonal indices which eliminate the seasonal effects, i.e.,

$$\text{Deseasonalised value} = \frac{\text{original value}}{\text{adjusted seasonal values}} \times 100 \qquad ...(3)$$

After we obtain the deseasonalised data, we can apply trend analysis as explained in Lab Session 15.

Steps in Excel

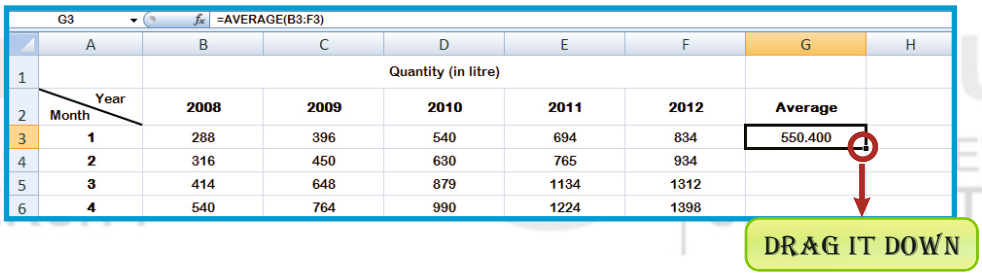
In the data given in Lab Session 16, we have monthly sales of the ice-cream parlour for 5 years. After going through the following steps, you will be able to apply the simple average method in Excel 2007:

Step 1: We enter the given data in an Excel sheet as shown in Fig.17.1.

	A	B	C	D	E	F
1		Quantity (in litre)				
2	Year / Month	2008	2009	2010	2011	2012
3	1	288	396	540	694	834
4	2	316	450	630	765	934
5	3	414	648	879	1134	1312
6	4	540	764	990	1224	1398
7	5	558	824	1032	1210	1475
8	6	586	802	1020	1237	1446
9	7	558	812	1005	1248	1456
10	8	548	776	1017	1217	1411
11	9	540	767	967	1215	1379
12	10	565	738	924	1134	1358
13	11	465	689	848	1024	1189
14	12	396	596	774	898	1064
15						

Fig. 17.1

Step 2: We type "=Average(B3:F3)" in Cell G3 to calculate the monthly average sales for the month of January. We drag down Cell G3 up to Cell G14 to get the monthly averages for all 12 months as shown in Fig. 17.2.



	A	B	C	D	E	F	G	H
1		Quantity (in litre)						
2	Year / Month	2008	2009	2010	2011	2012	Average	
3	1	288	396	540	694	834	550.400	
4	2	316	450	630	765	934	619.000	
5	3	414	648	879	1134	1312	877.400	
6	4	540	764	990	1224	1398	983.200	
7	5	558	824	1032	1210	1475	1019.800	
8	6	586	802	1020	1237	1446	1018.200	
9	7	558	812	1005	1248	1456	1015.800	
10	8	548	776	1017	1217	1411	993.800	
11	9	540	767	967	1215	1379	973.600	
12	10	565	738	924	1134	1358	943.800	
13	11	465	689	848	1024	1189	843.000	
14	12	396	596	774	898	1064	745.600	
15								

Fig. 17.2

Step 3: We compute the grand average of the monthly averages given in Cells G3:G14 by typing "=Average(G3:G14)" in Cell G15 as shown in Fig. 17.3.

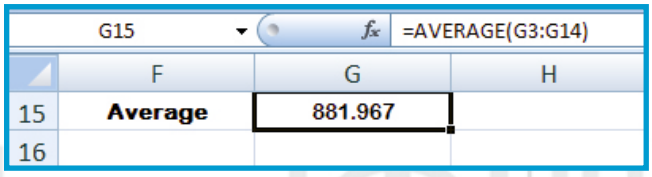
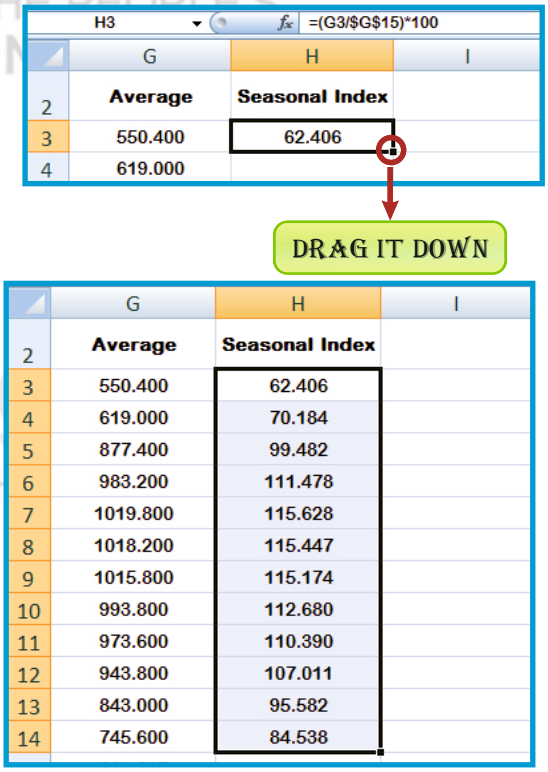


Fig. 17.3

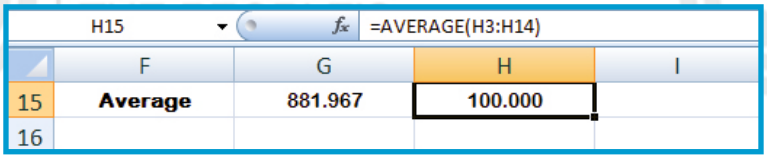
Step 4: To determine the seasonal indices, we type "=(G3/$G$15)*100" in Cell H3 and then drag it down up to Cell H14 as shown in Fig. 17.4. These seasonal indices are known as adjusted seasonal indices.



	G	H	I
2	Average	Seasonal Index	
3	550.400	62.406	
4	619.000	70.184	
5	877.400	99.482	
6	983.200	111.478	
7	1019.800	115.628	
8	1018.200	115.447	
9	1015.800	115.174	
10	993.800	112.680	
11	973.600	110.390	
12	943.800	107.011	
13	843.000	95.582	
14	745.600	84.538	

Fig. 17.4

Step 5: We can now verify that the average of the seasonal indices will be 100 as shown in Fig. 17.5.



	F	G	H	I
15	Average	881.967	100.000	
16				

Fig. 17.5

Step 6: We type (or ***Copy*** and ***Paste***) the given data in Cells A17:B77 as shown in Fig. 17.6.

	A	B
17	Month	Quantity (in litre)
18	1	288
19	2	316
20	3	414
21	4	540
22	5	558
23	6	586
24	7	558
25	8	548
26	9	540
27	10	565
28	11	465
29	12	396
30	13	396
31	14	450
32	15	648
33	16	764
34	17	824
35	18	802
36	19	812

Simple Averages

Fig. 17.6

Step 7: We now copy these adjusted seasonal indices from H3:H14 and paste these values in Cells C18, C30, C42, C54 and C66 using ***Paste Values*** option as shown in Fig. 17.7.

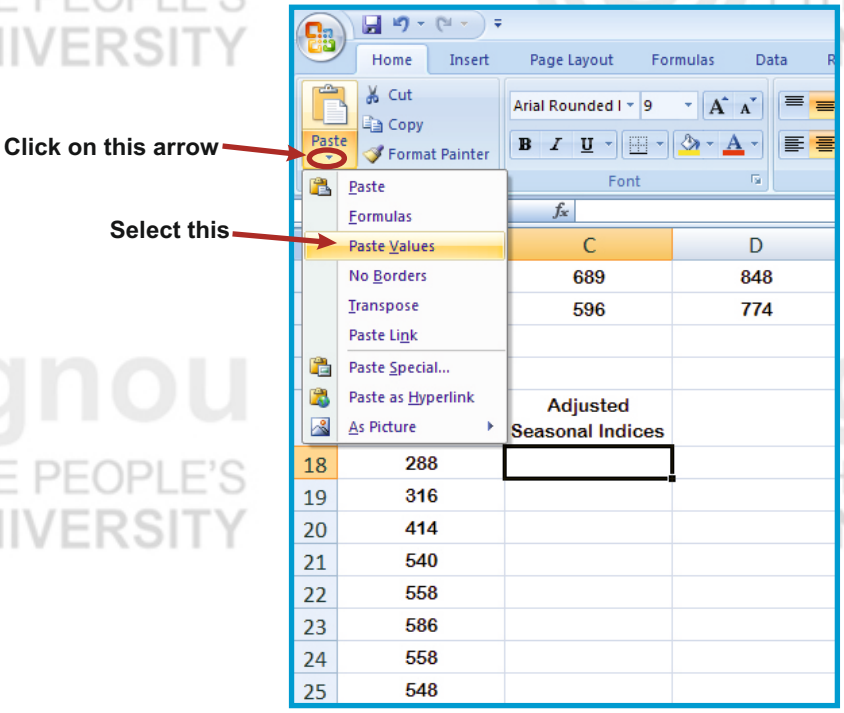


Fig. 17.7

The values given in Cells C18:C77 are the adjusted seasonal indices corresponding to the given data (Fig. 17.8).

	A	B	C
17	Month	Quantity (in litre)	Adjusted Seasonal Indices
18	1	288	62.406
19	2	316	70.184
20	3	414	99.482
21	4	540	111.478
22	5	558	115.628
23	6	586	115.447
24	7	558	115.174
25	8	548	112.680
26	9	540	110.390
27	10	565	107.011
28	11	465	95.582
29	12	396	84.538
30	13	396	62.406
31	14	450	70.184
32	15	648	99.482
33	16	764	111.478
34	17	824	115.628
35	18	802	115.447
36	19	812	115.174

Simple Averages

Fig. 17.8

Step 8: We also compute deseasonalised values for the given data by typing "=(B18/C18)*100" in Cell D18 and drag it down up to Cell D77 as shown in Fig. 17.9. Once the data are deseasonalised, the seasonal influences are removed from the data.

D18 =B18/C18*100

	B	C	D	E
17	Quantity (in litre)	Adjusted Seasonal Indices	Deseasonalised Values	
18	288	62.406	461.494	
19	316	70.184		

DRAG IT DOWN

	B	C	D	E
17	Quantity (in litre)	Adjusted Seasonal Indices	Deseasonalised Values	
18	288	62.406	461.494	
19	316	70.184	450.245	
20	414	99.482	416.155	
21	540	111.478	484.400	
22	558	115.628	482.582	
23	586	115.447	507.594	
24	558	115.174	484.483	
25	548	112.680	486.333	
26	540	110.390	489.176	
27	565	107.011	527.984	
28	465	95.582	486.494	
29	396	84.538	468.427	
30	396	62.406	634.555	
31	450	70.184	641.171	
32	648	99.482	651.373	
33	764	111.478	685.336	
34	824	115.628	712.630	
35	802	115.447	694.694	
36	812	115.174	705.018	

Simple Averages

Fig. 17.9

Step 9: We plot the given data and the deseasonalised values in Excel 2007 as explained in Sec. 15.3 of Lab Session 15. The resulting graph is shown in Fig. 17.10.

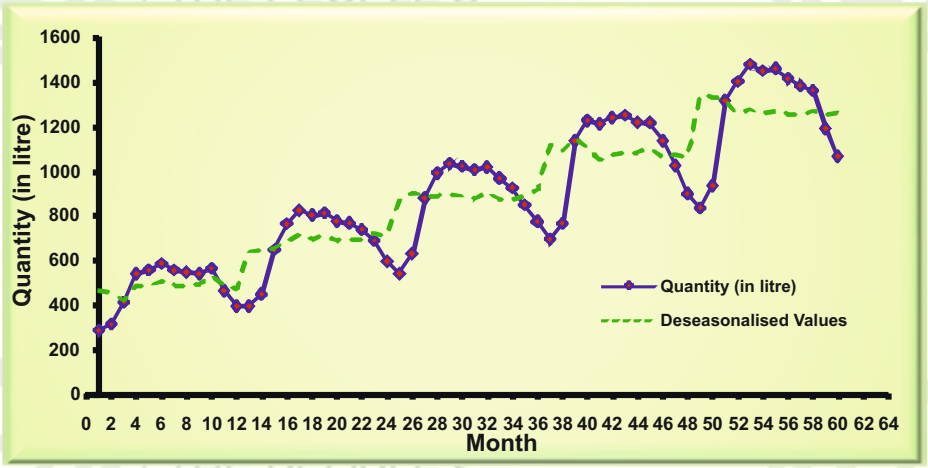


Fig. 17.10

Fig. 17.10 reveals that the deseasonalised values obtained after eliminating the seasonal effects have less crests and troughs in comparison with the original data and show an upward linear trend.

17.4 RATIO TO TREND METHOD

This method provides seasonal indices free from trend and is an improved version of the simple average method as it assumes that the seasonal variation for a given period is a constant fraction of trend. The measurement of the seasonal indices by this method consists of the following steps:

Step 1: We compute the yearly averages for the given characteristic or variable.

Step 2: We establish a trend by fitting a suitable curve using the method of least squares and taking the yearly averages as the dependent variable and year as the independent variable. Then we obtain the trend values for each period.

Step 3: On the basis of these yearly trend values, we determine the trend values for each season (e.g., month) by computing the monthly increment from the slope of the fitted trend curve.

Step 4: To express the original time series values as percentages of the trend values, we divide each original value by the corresponding trend value and multiply it by 100. The seasonal indices so obtained are free from the trend and known as the ratio to trend or trend eliminated values.

Step 5: To obtain the seasonal indices, we determine the average (mean or median) of the ratio to trend values for each season.

Step 6: We compute the grand average of all the seasonal indices obtained in Step 5.

Step 7: If the seasonal periods are quarters, the sum of the seasonal indices in case of multiplicative model should be 400. If seasonal periods are months, it should be 1200 and the average of these should be 100. But as often the sum (or average) of all seasonal indices is not exactly what it should be, we divide each seasonal index by the grand average obtained in Step 6 and multiply it by 100. It will make the average equal to 100.

Step 8: To adjust seasonality of the data, we can also obtain the deseasonalised values by dividing the original (given) values with the corresponding adjusted seasonal indices which eliminate the seasonal effects, i.e.,

$$\text{Deseasonalised value} = \frac{\text{original value}}{\text{adjusted seasonal value}} \times 100 \qquad ...(4)$$

After we obtain the deseasonalised data, we can apply trend analysis as explained in Lab Session 15.

Steps in Excel

Step 1: For applying the ratio to trend method, we arrange (or type) the data in the same way as explained in Step 1 of Sec. 17.3 (see Fig. 17.11).

	A	B	C	D	E	F
1		Quantity (in litre)				
2	Year / Month	2008	2009	2010	2011	2012
3	1	288	396	540	694	834
4	2	316	450	630	765	934
5	3	414	648	879	1134	1312
6	4	540	764	990	1224	1398
7	5	558	824	1032	1210	1475
8	6	586	802	1020	1237	1446
9	7	558	812	1005	1248	1456
10	8	548	776	1017	1217	1411

Fig. 17.11

Step 2: We type "=Average(B3: B14)" in Cell B15 to compute the yearly average of 2008 and drag it right up to Cell F15 to obtain the remaining yearly averages as shown in Fig. 17.12.

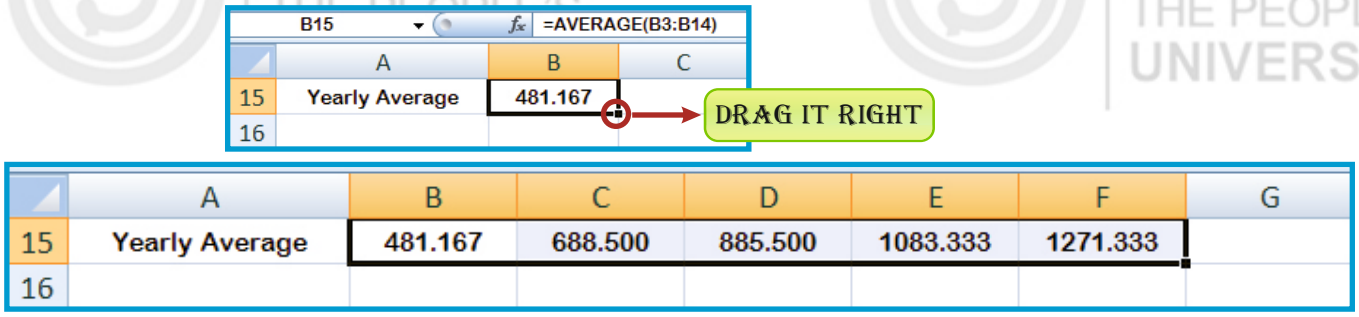


Fig. 17.12

Step 3: We now fit an appropriate trend line for the yearly average quantity of the ice-cream sold in different years. We follow the method explained in Lab Session 15 to fit a trend line. We plot the yearly averages on the graph and confirm that the linear trend line fits well (see Fig. 17.13).

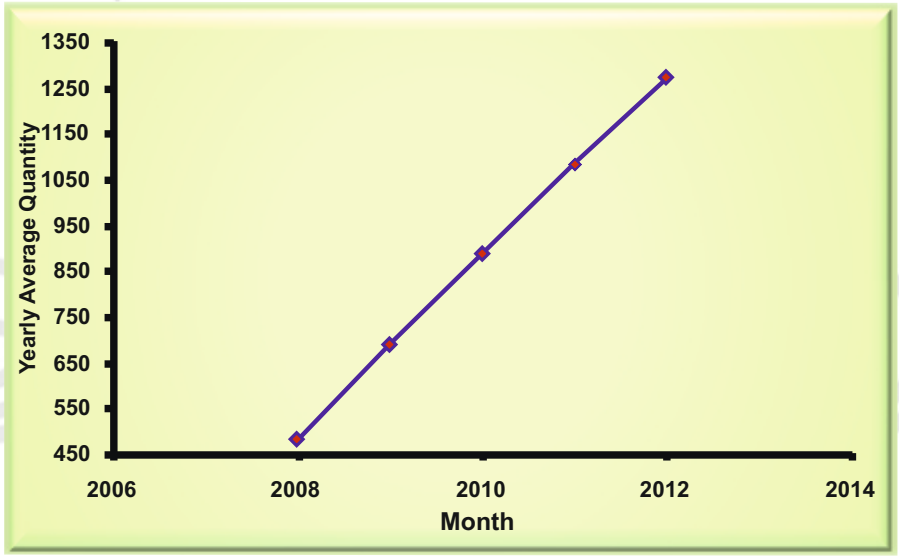


Fig. 17.13

Let the equation of the trend line be

$$\bar{y}_t = a_t + b_t x_t$$

where a_t is the intercept and b_t, the slope.

Here we are directly finding the values of intercept and slope by typing "=Intercept(B15:F15,B2:F2)" and "=Slope(B15:F 15, B2:F2)" in Cells B17 and B18, respectively, as shown in Fig. 17.14.

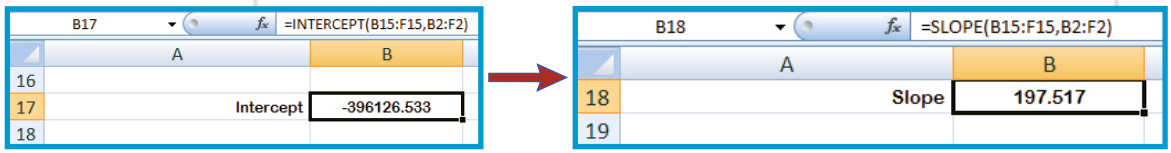


Fig. 17.14

Step 4: We type "=$B$17+$B$18*B2" in Cell B16 to obtain the trend value corresponding to the year 2008 and drag it right up to Cell F16 to determine the remaining trend values (see Fig. 17.15).

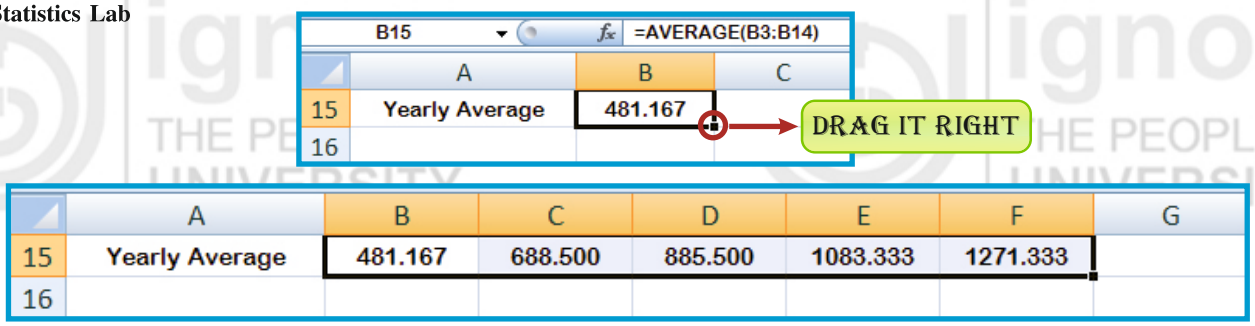


Fig. 17.15

Step 5: We obtained the equation of the linear trend for the yearly data in Step 3. The slope gives the yearly increment between the trend values. We can determine the monthly increment (as we have monthly data) between the trend value in Cell B20 by dividing the yearly increment by 12, i.e., by typing "=B19/12" in Cell B20 as shown in Fig. 17.16a. Then we compute the half monthly increment by typing "=B20/2" in Cell B21 as shown in Fig. 17.16b.

If we have quarterly data, we shall find quarterly increment by dividing yearly increment by 4 since we have 4 quarters in a year.

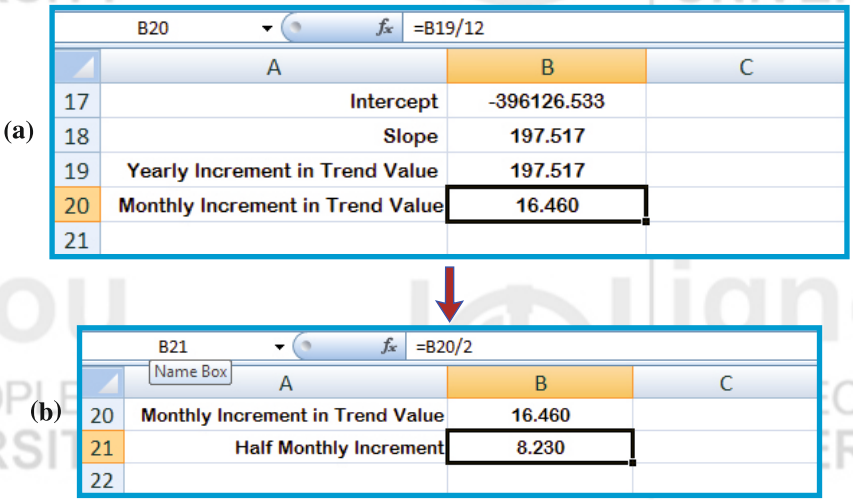


Fig. 17.16

Step 6: For finding trend values corresponding to each month, we consider Cells A23:F36 to compute the trend values as shown in Fig. 17.17.

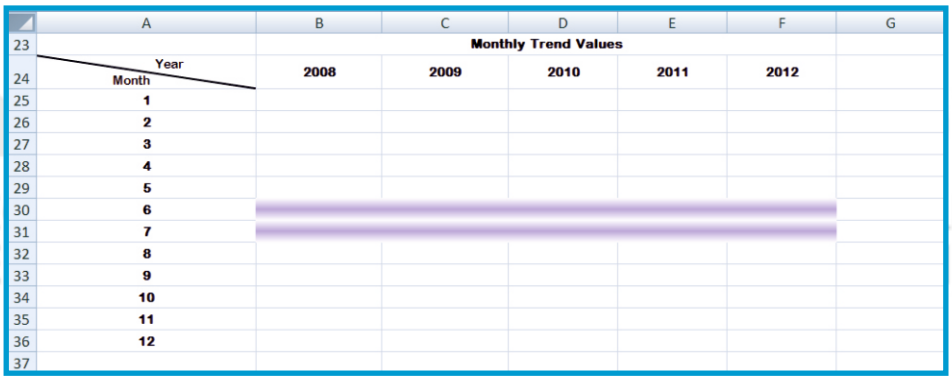


Fig. 17.17

In Cell B16, we have the trend value for the year 2008, i.e., 486.933 (Fig. 17.15). It corresponds to the middle of the months, i.e., between the 6th and 7th months. So we highlight Cells B30:F31 corresponding to the 6th and 7th months with purple colour as shown in Fig. 17.17.

Step 7: To obtain the trend values for the year 2008 corresponding to all months, we first need to compute the trend value of the 6th month of the year 2008.

To get the trend value for the 6th month, we type "=B$16-$B$21" in Cell B30 (Fig. 17.18a). We also type "=B$16+$B$21" in Cell B31 to get the trend values for the 7th month (see Fig. 17.18b).

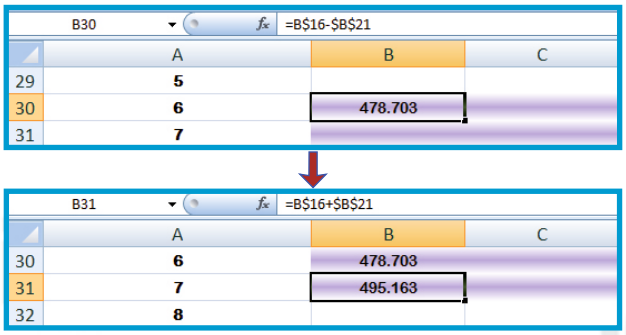


Fig. 17.18

Step 8: To obtain the trend value of the 5th month, we type "=B30-$B$20" in Cell B29 (Fig. 17.19a) and drag it up, up to Cell B25 to get the trend values of the 1st, 2nd, 3rd and 4th months (see Fig. 17.19b).

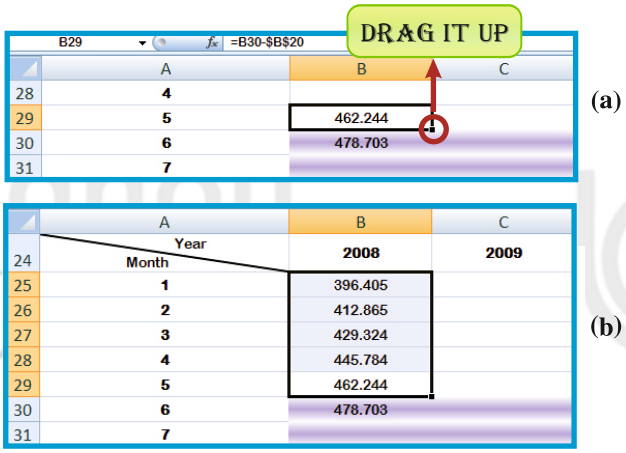


Fig. 17.19

Step 9: To obtain the trend value of the 8th month, we type "=B31+$B$20" in Cell B32 and drag it down up to Cell B36 to get the trend values of the 9th, 10th, 11th and 12th months (Fig. 17.20).

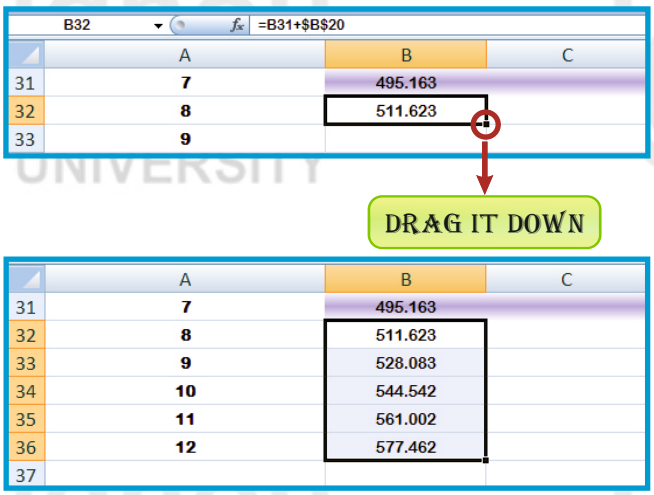


Fig. 17.20

The seasonal variations usually correspond to short term fluctuations. So before forecasting the future values, we should remove the seasonal component.

Step 10: We select Cells B25:B36 and drag them right up to Column F to obtain the month-wise trend values for all the years as shown in Fig. 17.21.

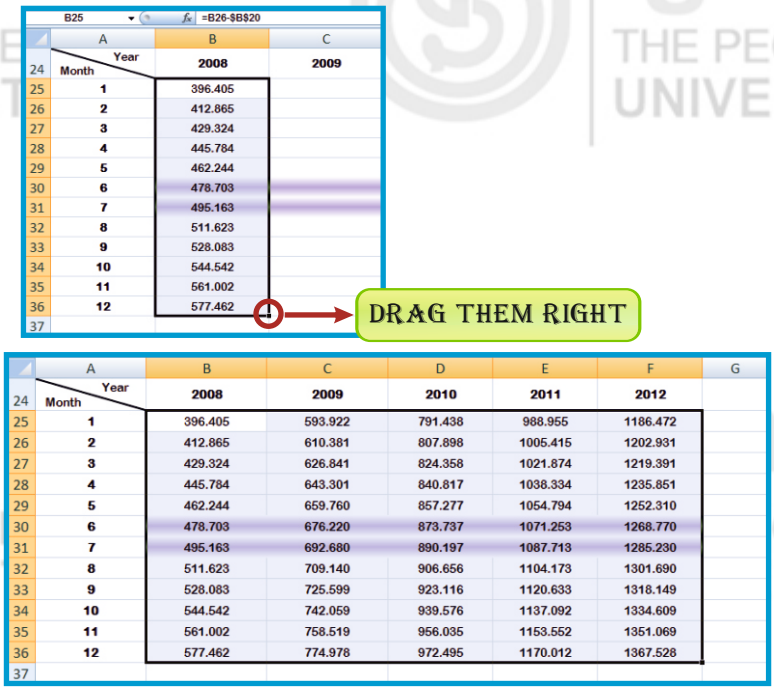


Fig. 17.21

Step 11: We compute the trend eliminated values corresponding to the given original values. For this purpose, we type "=(B3/B25)*100" in Cell B40 (see Fig. 17.22).

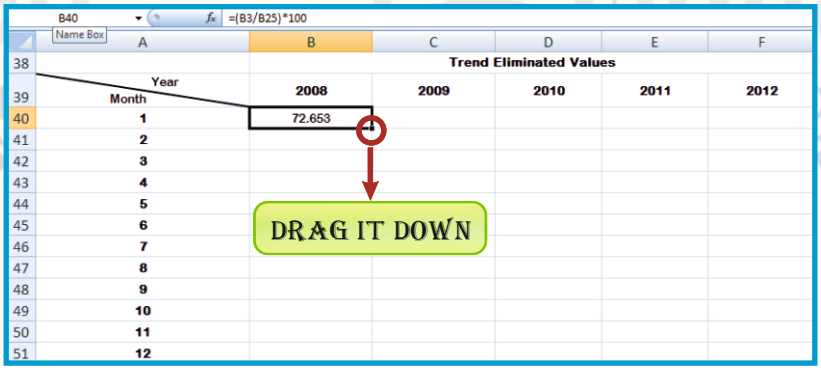


Fig. 17.22

Step 12: We drag Cell B40 down up to Cell B51 (Fig. 17.23) to compute the trend eliminated values for all months of the year 2008.

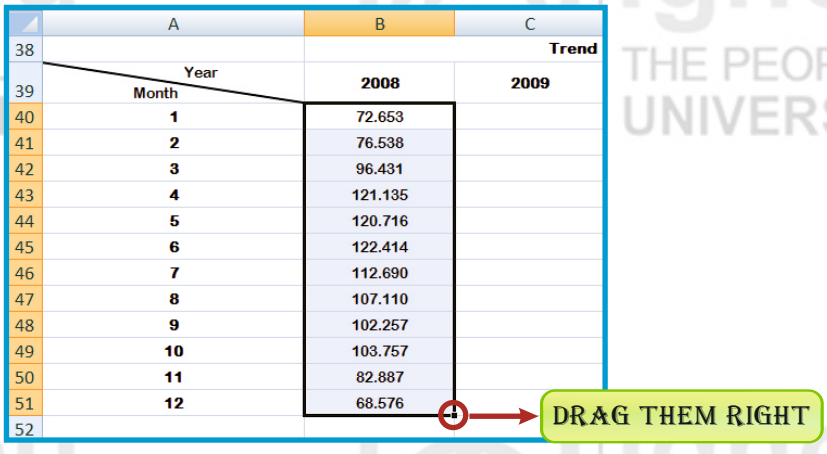


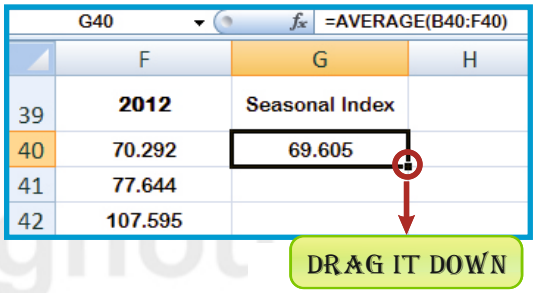
Fig. 17.23

Step 13: We select Cells B40:B51 and drag them right up to Column F (Fig. 17.24) to obtain the month-wise trend eliminated values for each given year.

	A	B	C	D	E	F
38		Trend Eliminated Values				
39	Year / Month	2008	2009	2010	2011	2012
40	1	72.653	66.675	68.230	70.175	70.292
41	2	76.538	73.724	77.980	76.088	77.644
42	3	96.431	103.376	106.628	110.973	107.595
43	4	121.135	118.763	117.743	117.881	113.120
44	5	120.716	124.894	120.381	114.714	117.782
45	6	122.414	118.600	116.740	115.472	113.969
46	7	112.690	117.226	112.896	114.736	113.287
47	8	107.110	109.428	112.170	110.218	108.398
48	9	102.257	105.706	104.754	108.421	104.616
49	10	103.757	99.453	98.342	99.728	101.753
50	11	82.887	90.835	88.700	88.769	88.004
51	12	68.576	76.905	79.589	76.751	77.805

Fig. 17.24

Step 14: To compute the seasonal indices, we type "=Average(B40:F40)" in Cell G40 and drag it down up to Cell G51 as shown in Fig. 17.25.



	F	G	H
39	2012	Seasonal Index	
40	70.292	69.605	
41	77.644	76.395	
42	107.595	105.000	
43	113.120	117.728	
44	117.782	119.697	
45	113.969	117.439	
46	113.287	114.167	
47	108.398	109.465	
48	104.616	105.151	
49	101.753	100.607	
50	88.004	87.839	
51	77.805	75.925	
52			

Fig. 17.25

Step 15: We calculate the average of the seasonal indices obtained in Step 14 by typing "=Average(G40:G51)" in Cell G52 as shown in Fig. 17.26.

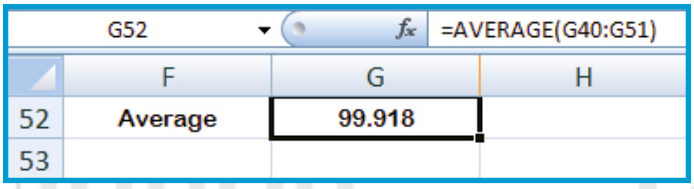
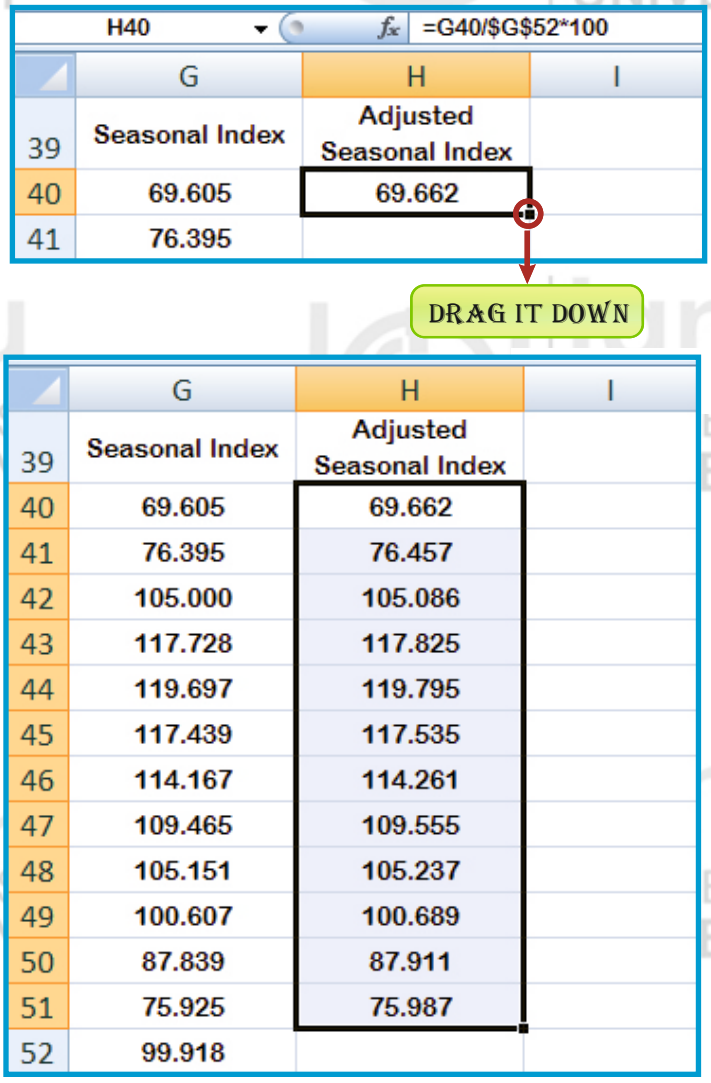


Fig. 17.26

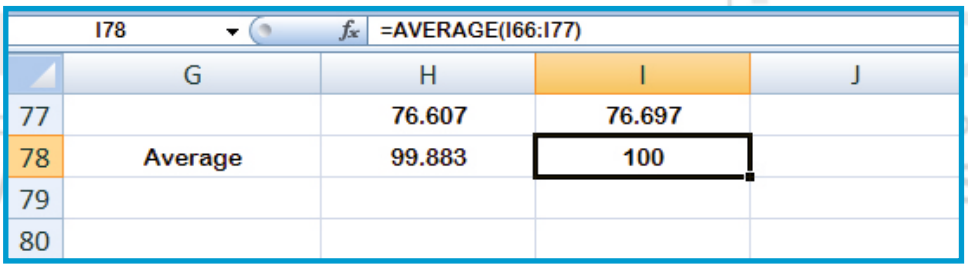
Step 16: The average given in Cell G52 (Fig. 17.26) is slightly different from 100, so we adjust the seasonal indices by typing "=(G40/$G$52)*100" in Cell H40. We drag Cell H40 down up to Cell H51 as shown in Fig. 17.27.



	G	H	I
39	Seasonal Index	Adjusted Seasonal Index	
40	69.605	69.662	
41	76.395	76.457	
42	105.000	105.086	
43	117.728	117.825	
44	119.697	119.795	
45	117.439	117.535	
46	114.167	114.261	
47	109.465	109.555	
48	105.151	105.237	
49	100.607	100.689	
50	87.839	87.911	
51	75.925	75.987	
52	99.918		

Fig. 17.27

Step 17: We can verify these averages by computing the grand average in Cell H52. It should be 100 as shown in Fig. 17.28.



	G	H	I	J
77		76.607	76.697	
78	Average	99.883	100	
79				
80				

Fig. 17.28

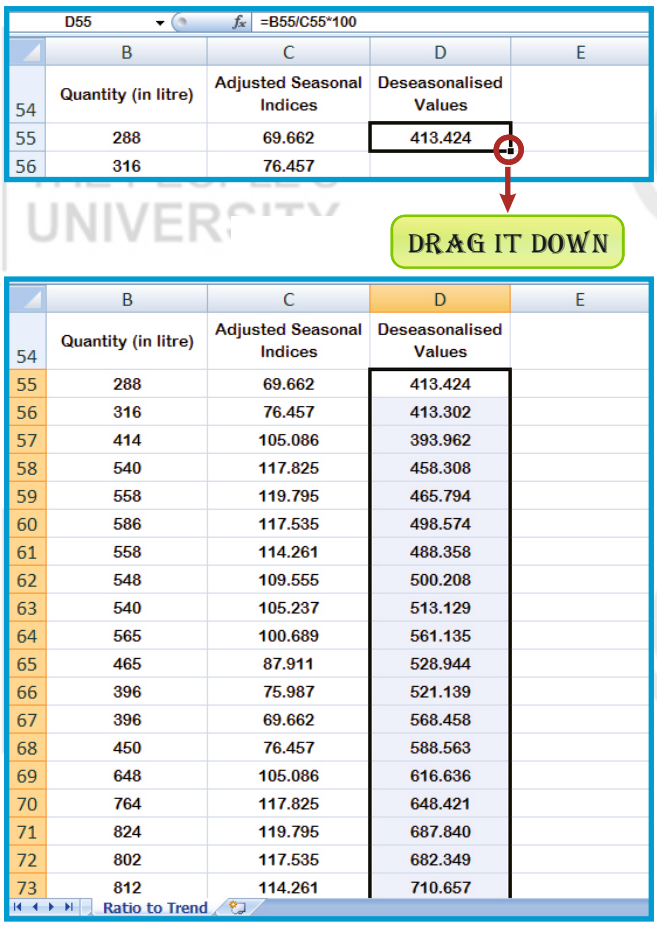
Step 18: We type the given data in Cells A54:B114. Then we copy the adjusted seasonal indices given in Cells H40:H51 and paste these values in Cells C55, C67, C79, C91 and C103 using ***Paste Values*** option as explained in Step 7 of Sec. 17.3. The values given in Cells C55:C114 are the adjusted seasonal indices corresponding to the given data (Fig. 17.29).

	A	B	C
54	Month	Quantity (in litre)	Adjusted Seasonal Indices
55	1	288	69.662
56	2	316	76.457
57	3	414	105.086
58	4	540	117.825
59	5	558	119.795
60	6	586	117.535
61	7	558	114.261
62	8	548	109.555
63	9	540	105.237
64	10	565	100.689
65	11	465	87.911
66	12	396	75.987
67	13	396	69.662
68	14	450	76.457
69	15	648	105.086
70	16	764	117.825
71	17	824	119.795
72	18	802	117.535
73	19	812	114.261

Ratio to Trend

Fig. 17.29

Step 19: We can also determine the deseasonalised values for the given data by typing "=(B55/C55)*100" in Cell D55 and dragging it down up to Cell D114 as shown in Fig. 17.30. By doing so, we may remove the seasonal influences on the data.



	B	C	D	E
54	Quantity (in litre)	Adjusted Seasonal Indices	Deseasonalised Values	
55	288	69.662	413.424	
56	316	76.457	413.302	
57	414	105.086	393.962	
58	540	117.825	458.308	
59	558	119.795	465.794	
60	586	117.535	498.574	
61	558	114.261	488.358	
62	548	109.555	500.208	
63	540	105.237	513.129	
64	565	100.689	561.135	
65	465	87.911	528.944	
66	396	75.987	521.139	
67	396	69.662	568.458	
68	450	76.457	588.563	
69	648	105.086	616.636	
70	764	117.825	648.421	
71	824	119.795	687.840	
72	802	117.535	682.349	
73	812	114.261	710.657	

Fig. 17.30

Step 20: We plot the given time series data and obtain deseasonalised values in Excel 2007 as explained in Sec. 15.3 of Lab Session 15. The resulting graph is shown in Fig. 17.31.

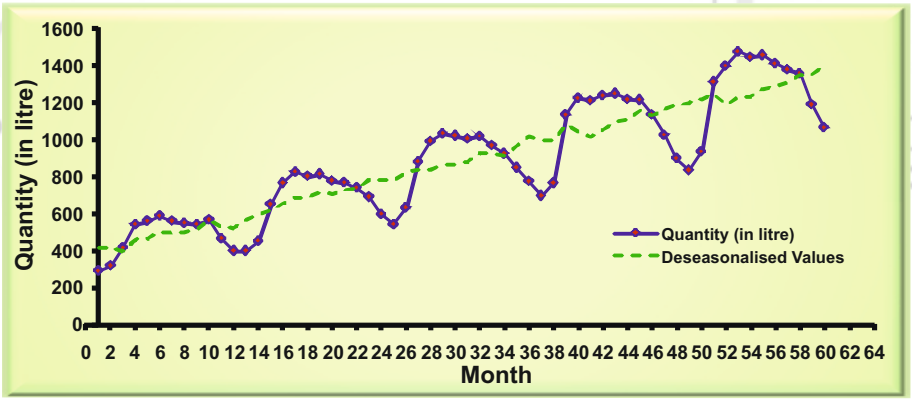


Fig. 17.31

If we have seasonal effect in our data, we should deseasonalise it before going for trend analysis or forecasting.

Fig. 17.31 reveals that the curve for deseasonalised values obtained after eliminating the seasonal effects is smooth (having fewer crests and troughs) in comparison with the original data and shows an upward linear trend.

17.5 RATIO TO MOVING AVERAGE METHOD

The ratio to moving average method is a better method than the methods discussed in Secs. 17.3 and 17.4 because of its accuracy. You have already studied the ratio to moving average method in Unit 13 of MSTE-002.

So here we briefly list the formulae and procedure in the steps given below:

Step 1: We eliminate the seasonal and irregular variations by computing moving averages as explained in Lab Session 16. It gives us estimates of the combined effect of trend and cyclic fluctuation, i.e., the time series obtained by the moving average method as

$$y_{MA} = TC \qquad ...(5)$$

Step 2: We divide the original (given) time series data by its corresponding moving average value. In this way, we obtain only seasonal and irregular components and eliminate the trend and cyclic fluctuation. These values are known as **Seasonal Relatives** and are given by

$$y_{SR} = \frac{TSCI}{y_{MA}} \times 100 = \frac{TSCI}{TC} \times 100$$

$$= SI \times 100 \qquad ...(6)$$

Step 3: We now determine the seasonal indices for all the given periods by calculating median of the seasonal relatives for each month.

Step 4: We compute the grand average of all the seasonal indices obtained in Step 3.

Step 5: If the seasonal periods are quarters, the sum of the seasonal indices in case of multiplicative model should be 400. If seasonal periods are months, it should be 1200 and the average of these should be 100. But as often the sum (or average) of all seasonal indices is not exactly what it should be, we divide each seasonal index by the grand average obtained in Step 4 and multiply it by 100. It will make the average equal to 100.

Step 6: To adjust seasonality of the data, we can also obtain the deseasonalised values by dividing the original (given) values with its corresponding adjusted seasonal indices, which eliminate the seasonal effects, i.e.,

$$\text{Deseasonalised value} = \frac{\text{original value}}{\text{adjusted seasonal value}} \times 100$$

$$= \frac{TSCI}{S} \times 100 = TCI \times 100 \qquad ...(7)$$

After we obtain the deseasonalised data, we can apply trend analysis as explained in Lab Session 15.

Steps in Excel

In Secs. 17.3 and 17.4, you have learnt the simple average method and ratio to trend methods for calculating the seasonal indices using Excel 2007. In this section, you will learn how to use ratio to moving average method in Excel 2007 in the steps given below:

Step 1: To apply the ratio to moving average method, we consider the same data as used in Secs. 17.3 and 17.4. We enter the data in Excel sheet named "**Ratio to Moving Average**" as shown in Fig. 17.32.

	A	B	C
1	Year	Month	Quantity (in litre)
2	2008	1	288
3		2	316
4		3	414
5		4	540
6		5	558
7		6	586
8		7	558
9		8	548
10		9	540
11		10	565
12		11	465
13		12	396
14	2009	13	396
15		14	450
16		15	648
17		16	764
18		17	824
19		18	802
20		19	812

Ratio to Moving Average

Fig. 17.32

Step 2: We have already seen from Fig. 16.8 of Lab Session 16 that the peaks are minimum or smoother for 12 months. We compute the 12 monthly centred moving averages in Column D as obtained in Sec.16.3 of Lab Session 16 (Fig. 17.33).

	A	B	C	D
1	Year	Month	Quantity (in litre)	12 Monthly Centred Moving Averages
2	2008	1	288	
3		2	316	
4		3	414	
5		4	540	
6		5	558	
7		6	586	
8		7	558	485.667
9		8	548	495.750
10		9	540	511.083
11		10	565	530.167
12		11	465	550.583
13		12	396	570.667
14	2009	13	396	590.250
15		14	450	610.333
16		15	648	629.292
17		16	764	645.958
18		17	824	662.500
19		18	802	680.167
20		19	812	694.500

Ratio to Moving Average

Fig. 17.33

Step 3: We determine the seasonal relatives by typing "=(C8/D8)*100" in Cell E8 and drag Cell E8 down up to Cell E55. The output is shown in Fig. 17.34.

E8 =(C8/D8)*100

	C	D	E	F
1	Quantity (in litre)	12 Monthly Centred Moving Averages	Seasonal Relatives	
2	288			
3	316			
4	414			
5	540			
6	558			
7	586			
8	558	485.667	114.894	
9	548	495.750		
10	540	511.083		

DRAG IT DOWN

	C	D	E	F
7	586			
8	558	485.667	114.894	
9	548	495.750	110.540	
10	540	511.083	105.658	
11	565	530.167	106.570	
12	465	550.583	84.456	
13	396	570.667	69.393	
14	396	590.250	67.090	
15	450	610.333	73.730	
16	648	629.292	102.973	
17	764	645.958	118.274	
18	824	662.500	124.377	
19	802	680.167	117.912	
20	812	694.500	116.919	
21	776	708.000	109.605	
22	767	725.125	105.775	
23	738	744.167	99.171	
24	689	762.250	90.390	
25	596	780.000	76.410	
26	540	797.125	67.743	
27	630	815.208	77.281	

Ratio to Moving Average

Fig. 17.34

Step 4: We now arrange the month-wise seasonal relatives obtained in Cells E8:E55 for all the years as shown in Fig. 17.35.

	B	C	D	E	F	G
64		Seasonal Relatives				
65	Month \ Year	2008	2009	2010	2011	2012
66	1		67.090	67.743	69.863	70.286
67	2		73.730	77.281	75.605	77.618
68	3		102.973	105.448	110.044	107.695
69	4		118.274	116.516	116.618	113.252
70	5		124.377	119.439	113.544	117.941
71	6		117.912	116.162	114.732	114.361
72	7	114.894	116.919	112.679	114.583	
73	8	110.540	109.605	112.505	110.431	
74	9	105.658	105.775	105.085	108.822	
75	10	106.570	99.171	98.237	100.250	
76	11	84.456	90.390	88.541	89.085	
77	12	69.393	76.410	79.449	76.804	
78						

Fig. 17.35

Step 5: In Cell H66, we determine the seasonal index by computing the median of all seasonal relatives corresponding to the month of January by typing "=Median(C66:G66)". We drag Cell H66 down up to Cell H77 to compute the seasonal indices for the remaining months as shown in Fig. 17.36.

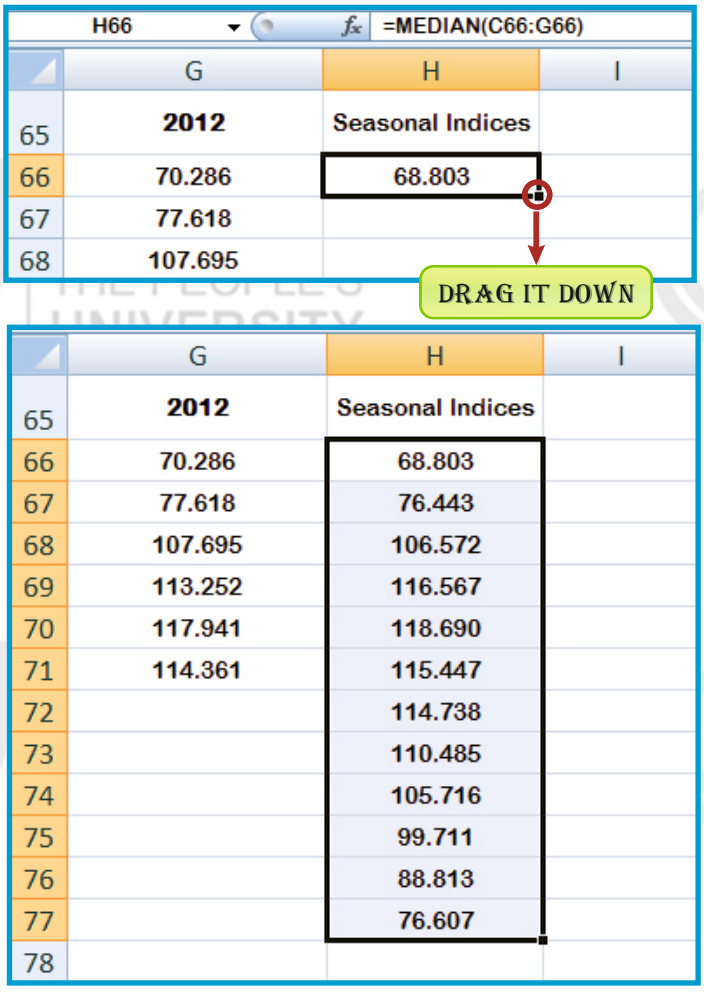


Fig. 17.36

Step 6: We determine the average of all seasonal indices computed in Cells H66:H77 by typing "=Average(H66:H77)" in Cell H78 as shown in Fig. 17.37. This is different from 100. So we need to adjust these seasonal indices so that the average turns out to be 100.

H78 =AVERAGE(H66:H77)

	G	H	I
78	Average	99.883	
79			

Fig. 17.37

Step 7: To compute the adjusted seasonal index for the month of January, we type "=(H66/$H$78)*100" in Cell I66 and drag it down up to Cell I77 to compute the adjusted seasonal indices for all months as shown in Fig. 17.38.

I66 =(H66/$H$78)*100

	H	I	J
65	Seasonal Indices	Adjusted Seasonal Indices	
66	68.803	68.884	
67	76.443		

DRAG IT DOWN

	H	I	J
65	Seasonal Indices	Adjusted Seasonal Indices	
66	68.803	68.884	
67	76.443	76.533	
68	106.572	106.697	
69	116.567	116.704	
70	118.690	118.829	
71	115.447	115.582	
72	114.738	114.873	
73	110.485	110.615	
74	105.716	105.840	
75	99.711	99.828	
76	88.813	88.917	
77	76.607	76.697	
78	99.883		

Fig. 17.38

Step 8: We can verify the average of the adjusted seasonal indices in Cell I78. It should be 100 as shown in Fig. 17.39.

I78 =AVERAGE(I66:I77)

	G	H	I	J
78	Average	99.883	100	
79				

Fig. 17.39

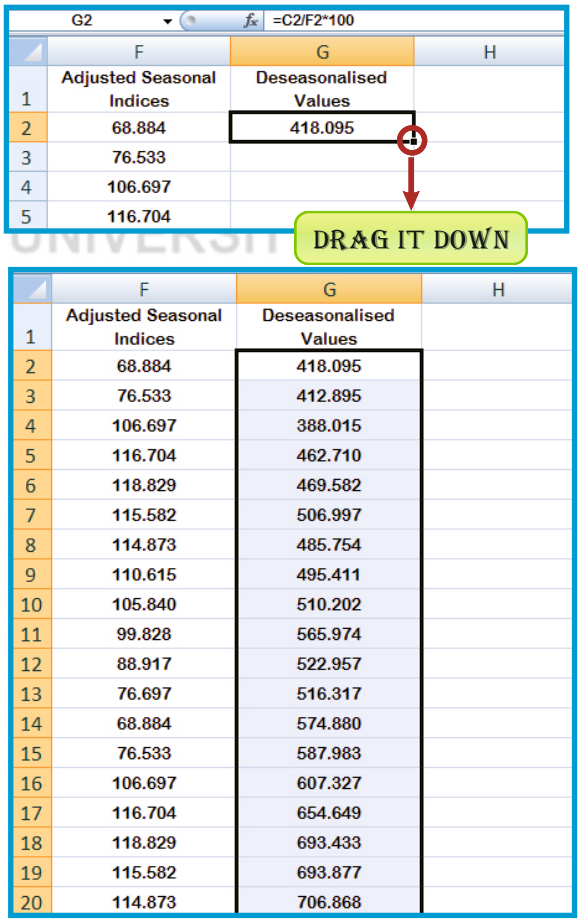
Step 9: We now copy these adjusted seasonal indices from Cells I66:I77 and paste these values in Cells F2, F14, F26, F38 and F50 using ***Paste Values*** option as explained in Step 7 of Sec. 17.3. The values given in Cells F2:F61 are the adjusted seasonal indices corresponding to the given data (Fig. 17.40).

	E	F
1	Seasonal Relatives	Adjusted Seasonal Indices
2		68.884
3		76.533
4		106.697
5		116.704
6		118.829
7		115.582
8	114.894	114.873
9	110.540	110.615
10	105.658	105.840
11	106.570	99.828
12	84.456	88.917
13	69.393	76.697
14	67.090	68.884
15	73.730	76.533
16	102.973	106.697
17	118.274	116.704
18	124.377	118.829
19	117.912	115.582
20	116.919	114.873

Ratio to Moving Average

Fig. 17.40

Step 10: We can also obtain the deseasonalised values for the given data by typing "=(C2/F2)*100" in Cell G2 and dragging it down up to Cell G61 as shown in Fig. 17.41 to eliminate the seasonal influences from the data.



	F	G	H
1	Adjusted Seasonal Indices	Deseasonalised Values	
2	68.884	418.095	
3	76.533	412.895	
4	106.697	388.015	
5	116.704	462.710	
6	118.829	469.582	
7	115.582	506.997	
8	114.873	485.754	
9	110.615	495.411	
10	105.840	510.202	
11	99.828	565.974	
12	88.917	522.957	
13	76.697	516.317	
14	68.884	574.880	
15	76.533	587.983	
16	106.697	607.327	
17	116.704	654.649	
18	118.829	693.433	
19	115.582	693.877	
20	114.873	706.868	

Fig. 17.41

Step 11: We plot the given data and the deseasonalised values in Excel 2007 as explained in Sec. 15.3 of Lab Session 15. The resulting chart is shown in Fig. 17.42.

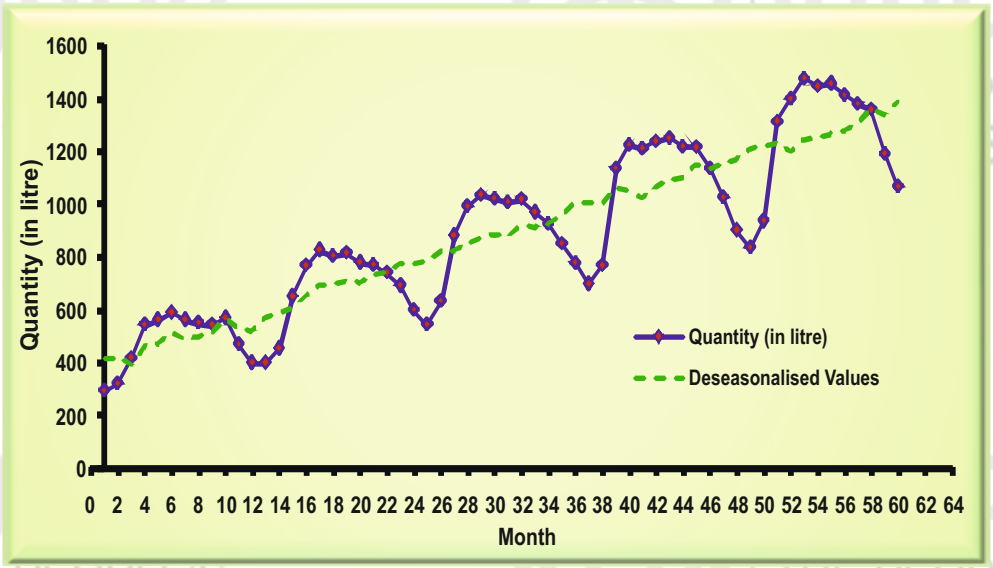


Fig. 17.42

Fig. 17.42 reveals that the deseasonalised data are smooth (having fewer crests and troughs) in comparison with the original data and show an upward trend.

You can now solve the following exercises to check whether you have learnt how to apply the seasonal analysis on the given data and deseasonalise the data.

Activity

Compute the seasonal indices with the help of MS Excel 2007 and interpret the results for

A1) Examples 1, 2 and 3 given in Unit 14 of MSTE-002.

A2) Exercises E1, E2, E3 and E4 given in Unit 14 of MSTE-002.

Match the results with the calculations done in Unit 14 of MSTE-002.

Continuous Assessment 17

Consider the data given in Continuous Assessment 16 of Lab Session 16 and use the simple average, ratio to trend and moving average methods to

- compute the seasonal indices for 7 years,
- obtain deseasonalised values and estimate the trend line by the method of least squares, and
- plot the given data and the deseasonalised values.

Home Work : Do It Yourself

1) Follow the steps explained in Secs. 17.3 to 17.5 to compute the seasonal indices and deseasonalised values for the data given in Table 1 of Lab Session 16. Use a different format for plotting the given data along with the deseasonalised values. Take the screenshots and keep them in your record book.

2) Develop the spreadsheets for the exercise given in "Continuous Assessment 17" as explained in this lab session. Take screenshots of the final spreadsheets and the charts.

3) **Do not forget** to keep the screenshots in your record book as these will contribute to your continuous assessment in the Laboratory.

APPENDIX

Table-I: Constants/Factors for Variable Control Charts

Sample Size (n)	c_4	d_2	d_3	A	A_2	A_3	B_3	B_4	D_1	D_2	D_3	D_4
2	0.798	1.128	0.853	2.121	1.880	2.659	0	3.267	0	3.686	0	3.267
3	0.886	1.693	0.888	1.732	1.023	1.954	0	2.568	0	4.358	0	2.574
4	0.921	2.059	0.880	1.500	0.729	1.628	0	2.266	0	4.698	0	2.282
5	0.940	2.326	0.864	1.342	0.577	1.427	0	2.089	0	4.918	0	2.114
6	0.952	2.534	0.848	1.225	0.483	1.287	0.030	1.970	0	5.078	0	2.004
7	0.959	2.704	0.833	1.134	0.419	1.182	0.118	1.882	0.204	5.204	0.076	1.924
8	0.965	2.847	0.820	1.061	0.373	1.099	0.185	1.815	0.388	5.306	0.136	1.864
9	0.969	2.970	0.808	1.000	0.337	1.032	0.239	1.761	0.547	5.393	0.184	1.816
10	0.973	3.078	0.797	0.949	0.308	0.975	0.284	1.716	0.687	5.469	0.223	1.777
11	0.975	3.173	0.787	0.905	0.285	0.927	0.321	1.679	0.811	5.535	0.256	1.744
12	0.978	3.258	0.778	0.866	0.266	0.886	0.354	1.646	0.922	5.594	0.283	1.717
13	0.979	3.336	0.770	0.832	0.249	0.850	0.382	1.618	1.025	5.647	0.307	1.693
14	0.981	3.407	0.763	0.802	0.235	0.817	0.406	1.594	1.118	5.696	0.328	1.672
15	0.982	3.472	0.756	0.775	0.223	0.789	0.428	1.572	1.203	5.741	0.347	1.653
16	0.984	3.532	0.750	0.750	0.212	0.763	0.448	1.552	1.282	5.782	0.363	1.637
17	0.985	3.588	0.744	0.728	0.203	0.739	0.466	1.534	1.356	5.820	0.378	1.622
18	0.985	3.640	0.739	0.707	0.194	0.718	0.482	1.518	1.424	5.856	0.391	1.608
19	0.986	3.689	0.734	0.688	0.187	0.698	0.497	1.503	1.487	5.891	0.403	1.597
20	0.987	3.735	0.729	0.671	0.180	0.680	0.510	1.490	1.549	5.921	0.415	1.585

Dear Learner,

While performing the Lab Sessions of MSTL-002, you may have found certain portions of the sessions difficult to perform. We wish to know your difficulties and suggestions in order to improve the course. Therefore, we request you to fill and send us the following feedback form, which pertains to this course. Just fill in the space provided or tick the most relevant option. If you find that the space provided is insufficient, kindly use a separate sheet.

Please mail to:

The Course Coordinator (MSTL-002)
Room No. 106
School of Sciences,
Block D, New Academic Complex,
IGNOU, Maidan Garhi
New Delhi – 110068

FEEDBACK FORM

1. Name: ……. 2. Male/Female: …… 3. Age: ……

4. Enrolment No: ……. 5. Email Address: ……

6. Mobile No: …….. 6. Employed/Unemployed: …….

7. Regional Centre Code and Name: ……

8. Study Centre Code and Name: ……

9. How many hours did you spend for performing all lab sessions?

Part No.	**A**					**B**					**C**				**D**		
Exercise No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
No. of Hours																	

10. How do you find the relevance of lab sessions for theory courses?

i) Excellent ii) Good iii) Adequate iv) Poor v) Very poor

11. Did you enjoy practicing with MS Excel 2007? Yes/No

12. Do you have a personal computer? Yes/No

13. Where do you access the internet?

i) At home ii) At internet cafe iii) At work place iv) Other ……

14) Put a tick mark on what you think is correct, based on your experience with the course from amongst the options given below:

Items	Excellent	Good	Adequate	Poor	Very Poor	Give Specific Examples, if Poor or Very Poor
Quality of Presentation						
Language and Style						
Screenshots Used						
Conceptual Clarity						
Activities						
Continuous Assessment Exercises						

15) **Specific Feedback:** If you have found some sessions of the course to be difficult and not clear, please mention the page numbers and what is not clear about each lab session. Use additional pages, if need be.

Lab Session and Page Number	Explanation is not Clear	Language is Difficult	Steps are Difficult	Screenshots are not Clear	Activity and Continuous Assessment are Difficult

16) Your overall comments and suggestions on the course (Please write the comments on the course after studying it).

……

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