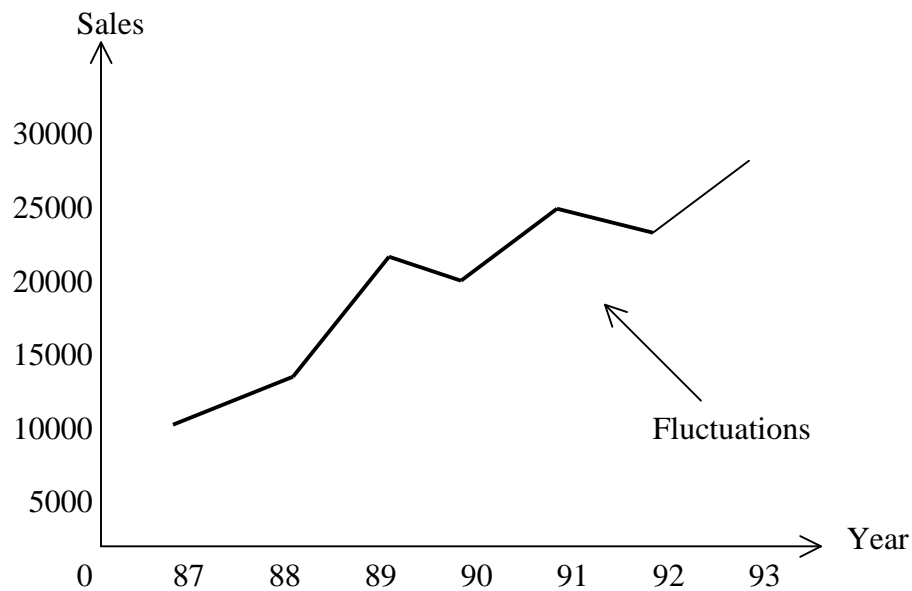


**CHAPTER SIX : TIME SERIES ANALYSIS****Introduction**

- A time series is a series of figures or values recorded over a particular period of time.

<u>Year</u>	<u>Sales (\$ thousands)</u>
87	10000
88	13000
89	21000
90	20000
91	25000
92	22000
93	27000



- The horizontal 'x' axis is always chosen to represent time and the vertical axis represents the values of the data recorded. The graphical representation of a time series as shown above reveals a particular characteristic that is inherent in almost every time series, namely the fluctuations; these fluctuations are due to several factors simply referred to as the components of a time series.

**Components of a Time Series**

There are altogether four components of a time series, namely:

- a) Trend
  - b) Seasonal Variation
  - c) Cyclical Variation
  - d) Random or Irregular Variation
- The variable under consideration may fluctuate as a result of any combination of the four components.

**a) Trend**

- The trend is actually the long-term movement of the variable. It indicates the general direction in which the data tends to be moving over a long period of time. If the variable value is on the rise, it is referred to as an upward trend. On the other hand, a decline in the variable value would be referred to as a downward trend.

**b) Seasonal Variations**

- The seasonal variations refer to the short-term fluctuations of the variable about the trend line. These seasonal variations recur at regular intervals of time. An example is the increased sales during the festive seasons (this recurs every year).

**c) Cyclical Variation**

- The cyclical variation refers to the long-term fluctuations which are actually the result of the influence of the business cycle on the variable.

**d) Irregular/Random Variation**

- Irregular variations refer to random and sporadic fluctuations in the time series, which do not follow any regular pattern. These irregular variations are mainly due to natural disasters such as earthquakes, floods, technological advancement, periods of unrest such as a war, strike, etc.

**Determining the trend: The Moving Average method**

- If the number of periods of the moving average is **even** then the moving average would have to be centered so that it corresponds to some defined period of time. On the other hand, if the number of periods of the moving average is **odd**, then centering is not necessary.

**Moving average for odd number of periods**

The following table shows the number of units of a product X sold for a 5-day period in a week for 3 weeks. Taking a moving average of 5 days, determine the trend.

Week	Days				
	Mon.	Tue.	Wed.	Thurs.	Fri.
1	8	10	12	11	9
2	7	9	13	12	8
3	8	11	12	12	9

**Solution**

Week	Day	Units of Product X Sold	Moving Total for 5-day Period	Moving Average (Trend) for 5-day Period
1	Mon.	8		
	Tues.	10		
	Wed.	12	50 (8 + 10 + 12 + 11 + 9)	10
	Thurs.	11	49 (10 + 12 + 11 + 9 + 7)	9.8
	Fri.	9	48 (12 + 11 + 9 + 7 + 9)	9.6
2	Mon.	7	49 (11 + 9 + 7 + 9 + 13)	9.8
	Tues.	9	50 (9 + 7 + 9 + 13 + 12)	10
	Wed.	13	49 (7 + 9 + 13 + 12 + 8)	9.8
	Thurs.	12	50 (9 + 13 + 12 + 8 + 8)	10
	Fri.	8	52 (13 + 12 + 8 + 8 + 11)	10.4
3	Mon.	8	51 (12 + 8 + 8 + 11 + 12)	10.2
	Tues.	11	51 (8 + 8 + 11 + 12 + 12)	10.2
	Wed.	12	52 (8 + 11 + 12 + 12 + 9)	10.4
	Thurs.	12		
	Fri.	9		

**Moving Average for Even Number of periods**

For the following data, using the moving average method, determine the trend.

**Number Employed (Thousand)**

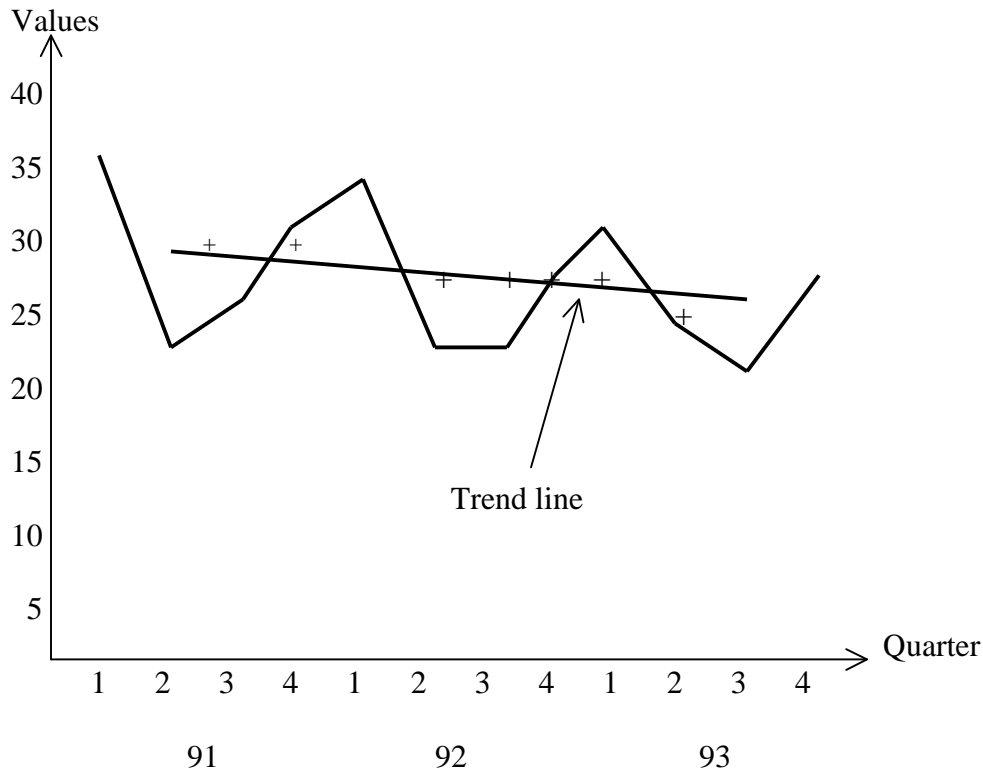
<u>Year</u>	<u>Q1</u>	<u>Q2</u>	<u>Q3</u>	<u>Q4</u>
2001	36	24	25	30
2002	32	23	23	27
2003	28	21	30	25

**Solution**

Year	Quarter	Actual data (E)	4-Quarter Moving Total	4-Quarter Moving Total (Centered)	4-Quarter Moving Average Centered (Trend)
91	1	36			
	2	24			
			115		
	3	25		226	28.25
92	4	30		221	27.63
			110		
	1	32		218	27.25
	2	23		213	26.63
93			105		
	3	23		206	25.75
			101		
	4	27		200	25.00
93			99		
	1	28		195	24.38
			96		
	2	21		190	23.75
93			94		
	3	20			
	4	25			

**Plotting the actual and trend values**

- The actual values and the trend values computed using the moving average method can be plotted on a graph as shown in the example below. The actual values are plotted as a line graph while the trend values are approximated to be a linear line.



∴ From the trend line, it can be seen that a downward trend is indicated.

***Learning Outcomes***

- Students should be able to identify trend, seasonal variation, cyclical variation and random variation.
- Students should be able to calculate moving average with odd number of periods.
- Students should be able to calculate moving average with even number of periods.
- Students should be able to calculate regression line.
- Students should be able to draw histogram.
- Students should be able to draw trend line.

**Basic Reading**

1. Saravanan Kullandavelli (1994) LCCI Business Statistics; 5<sup>th</sup> ed. Malaysia; Stamford College Group Publishing.
2. A. Francis (1995) Business Mathematics and Statistics; 4<sup>th</sup> ed. London DP Publications Ltd.

**Revision Questions**

1. A time series data is given as follows. By means of the four-quarter moving average, establish the trends of the data

<u>Year</u>	<u>Quarter</u>			
	<u>Q1</u>	<u>Q2</u>	<u>Q3</u>	<u>Q4</u>
1991	10	50	20	60
1992	30	70	40	80
1993	50	90	60	100

2. The sales of a product have been recorded for the last three weeks. The following table shows the number of items sold each day over the three-week period.

<u>Week</u>	<u>Mon</u>	<u>Tues</u>	<u>Wed</u>	<u>Thurs</u>	<u>Fri</u>
1	376	594	667	674	571
2	426	634	712	729	602
3	459	697	751	795	645

Using a suitable moving average, establish the trend of the data