

ST MIRA'S COLLEGE FOR GIRLS, PUNE
(Autonomous-Affiliated to the University of Pune)

CLASS: FYBCOM/FYBA

SEMESTER: I

SUBJECT: BUSINESS MATHEMATICS & STATISTICS

TITLE: PROJECT ASSIGNMENT ON TIME SERIES ANALYSIS
YEAR 2022-2023

Maximum Marks: 20 M

Write a project assignment on “Time series Analysis” in Minimum 5 pages and Maximum 10 pages. The assignment should cover the following points:

- **Basic definition and terminology used in time series (2M)**
- **Important Mathematical formulae and variables used in the process.(2M)**
- **Aims and objectives of the project. (2M)**
- **Solution of two real life problems used different techniques in Time series Analysis. (10M)**
- **Relevant Conclusions and general trend observed. (4M)**



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STD : FYBCOM 'B'

ROLL NO : 3303

SUBJECT : MATHS

ASSIGNMENT

TOPIC : TIME SERIES ANALYSIS

SEMISTER : I



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Introduction



Time Series is a sequence of data-points measured at a regular time-intervals over a period of time. Irregular data does not form Time-Series.

It uses statistical methods to analyze time series data and extract meaningful insights about the data.

The data points are collected over a period. These data points (past values) are analyzed to forecast a future. Obviously, it is time-dependent.

Time Series Analysis helps us to recognize the major components in a time series i.e. Secular trend, Seasonal variation, Cyclical variation, Irregular variations.

Few examples of Time Series are given below:
yearly, quarterly or monthly production of a commodity.

yearly production of steel in India.

monthly sales of a departmental store.

weekly price of a commodity.

daily closing price of a share at a stock exchange.

hourly temperature recorded by the meteorological office in a city.

According to Croxson & Cowden: "A time series consists of data arranged chronologically"

Utility of Time-Series

- 1) **PAST BEHAVIOUR** : Time Series analysis enables us to describe the past behaviour of the variable under consideration. This knowledge about the past behaviour is useful in understanding various forces working at times that are responsible for the fluctuations in the values of the variable over a period of time.
- 2) **FORECASTING** : We analyse the past in order to understand the future better. The past behaviour projected into the future behaviour to forecast the changes which are likely to occur in future. In economic or business phenomena, such a forecasting is of utmost importance in decision making to plan inventory, scheduling of purchases and sales, etc.
- 3) **COMPARISON** : Time Series analysis helps in comparing the behaviour of two or more time series. For example, production steel over the last ten years may be compared with the production of machines and steel appliances over the same sequence of years. The agricultural production over the last twenty years may be compared with population figures for the same sequence of years. Prices of gold and prices of shares may be compared over the last ten years.



Components of Time-Series

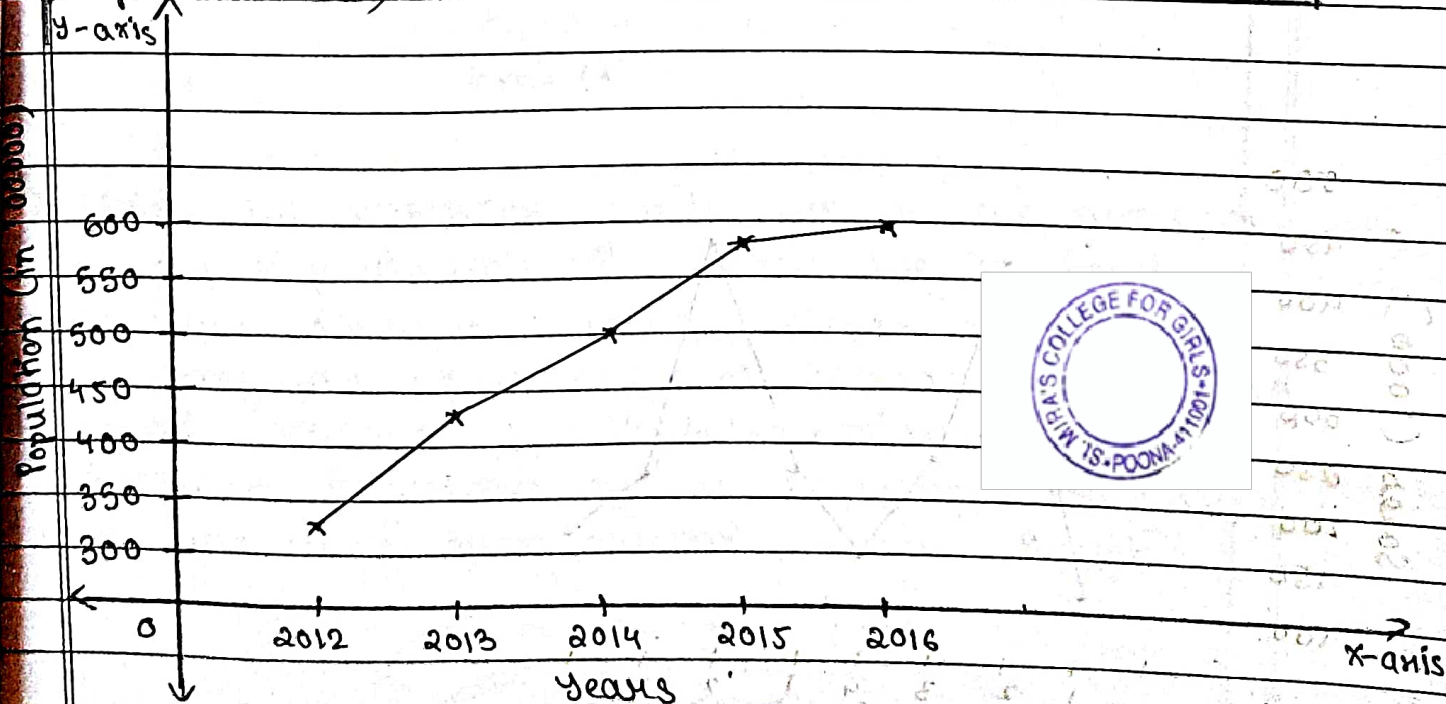
SECULAR TREND :

The time series data possess the general tendency of increase or decrease or to remain stagnant over a long period of time. This smooth, regular, long-term movement of the time series is called secular trend or simply trend. The concept of secular trend does not include short range oscillations but rather the steady movement of a long period of time.

Example :

Population in Pune from 2012 - 2016.

Year	2012	2013	2014	2015	2016
Population ('00000)	324	430	500	570	592



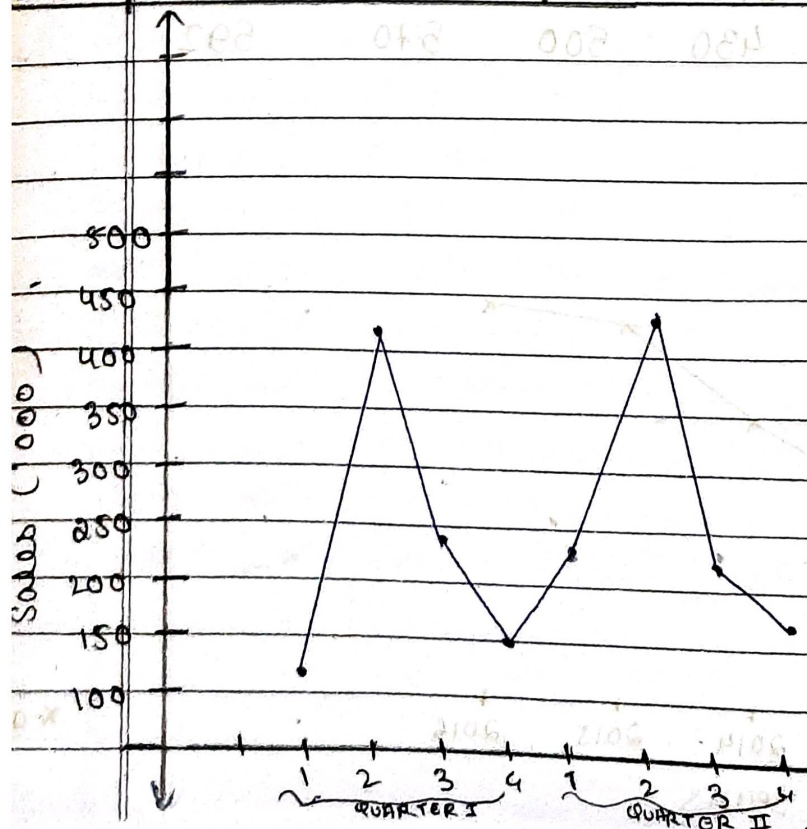
(3)

2) SEASONAL VARIATION :

If we observe the sale structure of clothes in the market we will find that the sale curve is not uniform throughout the year. Many business and economic time series met in practise consists of quaterly or monthly observations. It is often the case that such series exhibit the phenomenon of seasonality such that patterns are repeated from year to year. Seasonal variation involves patterns of change within a year that tend to be repeated from year to year.

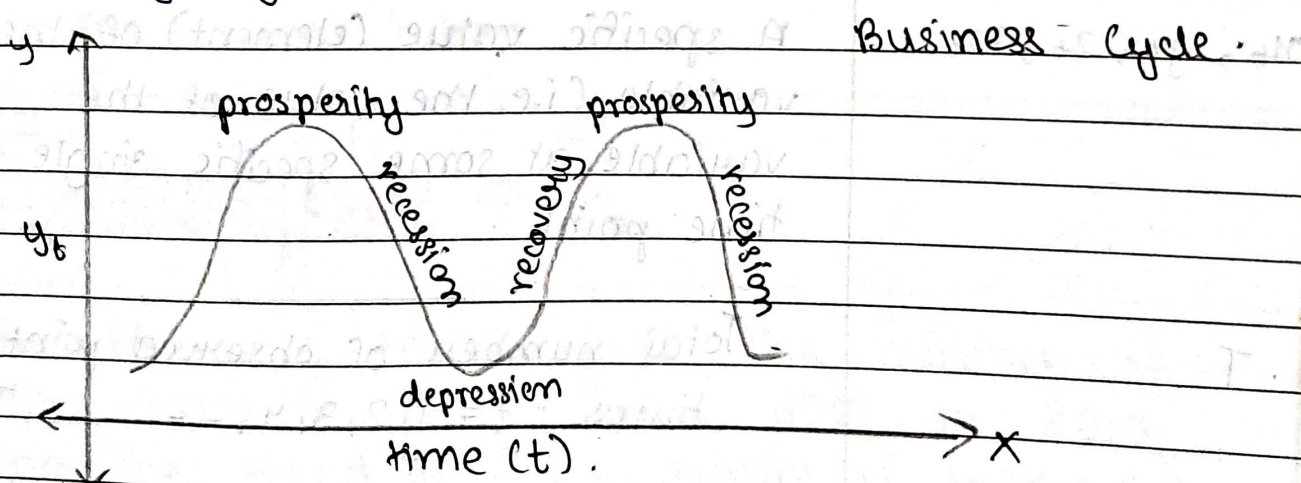
* Example : The following table gives the quaterly sales of cotton clothes for two consecutive years for a whole dealer.

Year	I				II			
Quarter	1	2	3	4	1	2	3	4
Sales	220	421	245	150	230	441	224	164



CYCLICAL VARIATION:

Apart from seasonal variations, there is another type of fluctuation which usually lasts for more than a year. This fluctuation is the effect of business cycles. In every business there are four important phases - i) prosperity, ii) decline, iii) depression, iv) improvement or regain. The time from prosperity to regain is a complete cycle. So, this cycle will never show regular periodicity. A period of a cycle may differ but, importantly, the sequence of changes should be more or less regular and it is this fact of regularity which enables us to study cyclical fluctuations.



IRREGULAR VARIATIONS: These are, as the name suggests, totally unpredictable. The effects due to flood, draughts, famines, earthquakes, etc are known as irregular variations. All variations excluding trend, seasonal and cyclical variations are irregular. Sometimes cyclical fluctuations too can get generated from natural calamities, though

Notations

x, y, z, w	Variables
x_t, y_t, z_t, w_t	Some single value (element) of the variable (i.e. the value of the variable at some unspecified single time point).
i, j, k, l, s, t	Indices (t is usually reserved to index time).
x_t, y_t, z_t, w_t	A specific value (element) of the variable (i.e. the value of the variable at some specific single time point).
T	Total number of observed point times : $t = 1, 2, 3, 4, \dots, T$

Some notation is specific to time series data. If y is a time series variable, we often given it to subscript t : y_t . The subscript t does not indicate that we are referring to a specific value of y_t . It only indicates that y is a times series variable. We all use y_t to denote the specific value of y_t at some time point t .



Aims and Objectives

Aim: The main aim of the project is to study the basic concepts of time series and also collect data, interpret and find detailed information about time series.

- OBJECTIVES:**
- ① To understand the concept of Time Series
 - ② To understand, interpret and evaluate chronological variations in the past in order to make reliable predictions in the future
 - ③ To make right decision for the betterment of the work taken

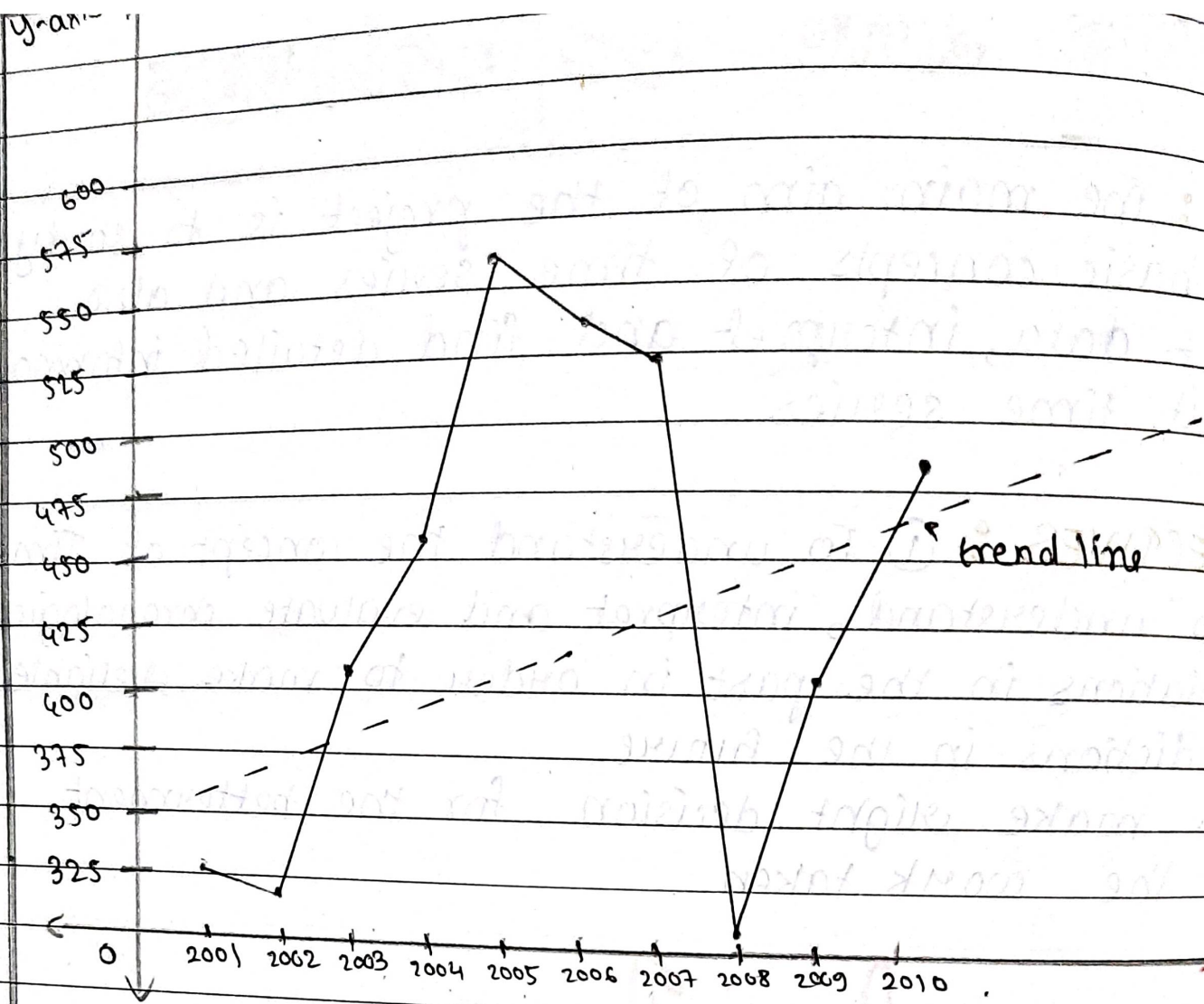
Example - 1

The following table gives the number of rape cases in Delhi from 2001 to 2010.

Find the trend line by graphical method to the data given below.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Rape cases	326	320	406	457	562	533	524	309	404	489





Example - 2

The data below gives the maximum temperature in Pune in the month of May from 2007-2016. Fit a trend line by the method of least squares.

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Temperature °C	41.9	38.6	40.3	41.9	40.4	39.4	41.3	40.4	40.0



Let the equation of the trend line be

$$y_t = a + bt$$

Here, $n=10$ (even), two middle t values are 2011 and 2012 and $h=1$.

We use the transformation

$$u = t - 2011.5 = 2t - 4023$$

$$\frac{1}{2}$$

The equation of the trend line becomes

$$y_t = a' + b'u$$

The two normal equations are

$$\sum y_t = na' + b'\sum u \quad \text{--- (1)}$$

$$\sum uy_t = a'\sum u + b'\sum u^2 \quad \text{--- (2)}$$

We obtain $\sum u$, $\sum u^2$, $\sum y_t$ and $\sum uy_t$ from the following table.

Year t	y_t	u	u^2	uy_t	Trend value
2007	41.9	-9	81	-377.1	40.465
2008	38.6	-7	49	-270.2	40.495
2009	40.3	-5	25	-201.5	40.525
2010	41.9	-3	9	-125.7	40.555
2011	40.4	-1	1	-40.4	40.585
2012	39.4	1	1	39.4	40.615
2013	41.3	3	9	123.9	40.645
2014	40.4	5	25	202	40.675
2015	40.8	7	49	285.6	40.705
2016	41.0	9	81	369	40.735
	406	0	330	5	

From (1) and (2),

$$406 = 10a' + b'(0) \quad \text{--- (3)}$$

$$5 = a'(\sum 0) + b'(330) \quad \text{--- (4)}$$

From (3), $a = 40.6$

From (4), $b = 0.015$



15
The equation of the trend line that we get is $y_t = 40.6 + (0.015)u$ where $u = 2t - 4023$.
Trend values computed during above equation of trend line is shown in the last column of Table.

Estimation of trend value for the year 2017

for $t = 2018$ 2017, $u = 2(2017) - 4023 = 11$

$$\hat{y}_t = 40.6 + (0.015)11 \\ = 40.765^\circ \text{C}.$$

Conclusion

We conclude that time series analysis helps in decision makings and reliable predictions about the future. As we see in Example 1 and Example 2, we realized that in Example 1, that in the year 2011, there could be a slight increase in the number of rape cases in Delhi. Whereas, in example 2, we calculated the trend value for the year 2017, which shows that there could be an increase in the temperature in the month of May 2017 in Pune.

Therefore, time series helps us in making reliable prediction about the future and make plans to make it better.

