1. What are the components of time series ?

Solution : The components of time series are :

(i) Secular Trend or Long-term Movement

(ii) Periodic Changes or Short-term Fluctuations.

     (a) Sessional Variations, and (b) Cyclic variations.

(iii) Random or Irregular Movements

2. What are the main problems in the analysis of time series ?

Solution : The main problems in the analysis of time series are :

(i) To identify the forces or components at work, the net effect of whose interaction is exhibited by the movement of a time series,

(ii) To isolate, study, analyse and measure them independently, i.e., by holding other things constant.

3. What are the mathematical models for time series ?

Solution : There are two models which are commonly used for the decomposition of a time series into its components :

(i) Decomposition by additive hypothesis or Additive Model,

(ii) Decomposition by multiplicative hypothesis or Multiplicative Model.

4. Explain decomposition by additive hypothesis or Additive Model of a time series into its components.

Solution : According to the additive model, a time series can be expressed as

$$y_t = T_t + S_t + C_t + R_t \ \ldots\ldots\ldots\ldots\ldots\ (i)$$

where, $y_t \rightarrow$ the time series value at time t,

$T_t \to$ the trend value at time t,

$S_t \to$ the seasonal fluctuation at time t,

$C_t \to$ the cyclic fluctuation at time t,

$R_t \to$ the random fluctuation at time t.

It is obvious that S_t will not appear in a series of annual data. The additive model implicitly implies that seasonal forces in different years, cyclic forces in different cycles and irregular forces in different long term period operate with equal absolute effect irrespective of the trend value. As such C_t and S_t will have positive and negative values, according as whether the observers are in an above normal and below normal phase of the cycle and year respectively. The total of positive and negative values for any cycle and any year will be zero. R_t will have positive or negative value and in the long term the sum of R_t will be zero. Occasionally, there may be a few isolated occurrences of extreme R_t of episodic nature.

Thus, additive model executes that all the four components of the time series operate independently of each other so that none of these components has any effect on the remaining three.

5. Explain decomposition by multiplicative hypothesis or Multiplicative Model of a time series into its components.

Solution : According to the additive model, a time series can be expressed as

$$y_t = T_t \times S_t \times C_t \times R_t \ \dots\dots\dots\dots\dots \text{(i)}$$

where, $y_t \to$ the time series value at time t,

$T_t \to$ the trend value at time t,

$S_t \to$ the seasonal fluctuation at time t,

$C_t \to$ the cyclic fluctuation at time t,

$R_t \to$ the random fluctuation at time t.

In multiplicative model, S_t, C_t and R_t are indices fluctuating above and below unity and the geometric means of S_t in a year, C_t in a cycle and R_t in a long term

period of unity. In a time series with both positive and negative values, the multiplicative value can not be applied unless the time series is translated by adding a suitable positive value. It is obvious that the multiplicative decomposition of a time series is the same as the additive decomposition of logarithmic values of the original time series, i.e.,

$$\log y_t = \log T_t + \log S_t + \log C_t + \log R_t$$

6. What are the uses of time series ?

Solution : The various uses of time series are :

(i) It enables us to study the past behaviour of the phenomenon under consideration, i.e., to determine the type and nature of the variations in the data.

(ii) The segregation and study of various components is of paramount importance to a businessman in the planning of future operations and in the formulation of executive and policy decisions.

(iii) It helps to compare the actual current performance of accomplishments with the expected ones (on the basis of the past performances) and analyse the causes of such variations, if any.

(iv) It enables us to predict or estimate or forcast the behaviour of the phenomenon in future which is very essential for business planning.

(v) It helps us to compare the changes in the values of different phenomenon at different times or places, etc.

7. What methods are used to measure the trend ?

Solution :   The trend can be measured by the following methods :

(i) Graphic (or Free-hand Curve Fitting) Method,

(ii) Semi-Averages Method,

(iii) Curve Fitting by Least Squares Method,

(iv) Moving Averages Method