Principles of Industrial Engineering
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Lecture 51
Forecasting: Methods 4

Hello, I welcome you all in this presentation related with the subject Principles of Industrial Engineering. In this presentation, I will be talking about the method for forecasting considering the seasonality factor. You must have seen that demand of certain items will be at the peak at certain period.

Like, the demand of the gold, demand of sugar, in in certain festive seasons or certain periods we will see that demand of the certain type of items will be very high as compared to the other period.

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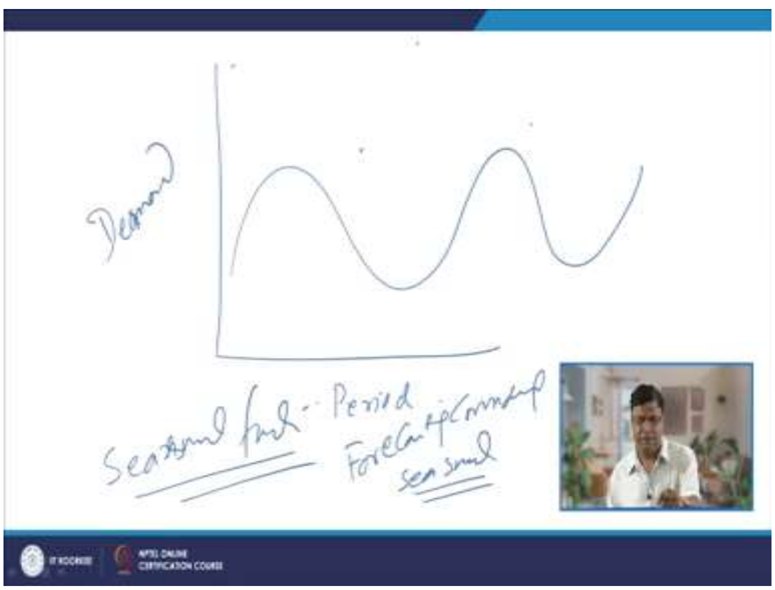

So in this case, if we just try to draw a demand pattern, in this case then what we notice, that like say, this is the demand, and for the different periods, maybe months, years or the time. So, the demand for the certain items may take this kind of the trend or here, the demand is high, then low, then high, then low, so as if for certain period the demand is high then for some other period, demand is low.

So this is the case when there is no trend only the cyclic variation is taking place in the demand as a function of time. And this can be attributed to the seasonal factors. So, determination of the forecast, means forecasting considering the seasonal factor needs a, a unique way of consideration of the methodology for determining the, a forecast.

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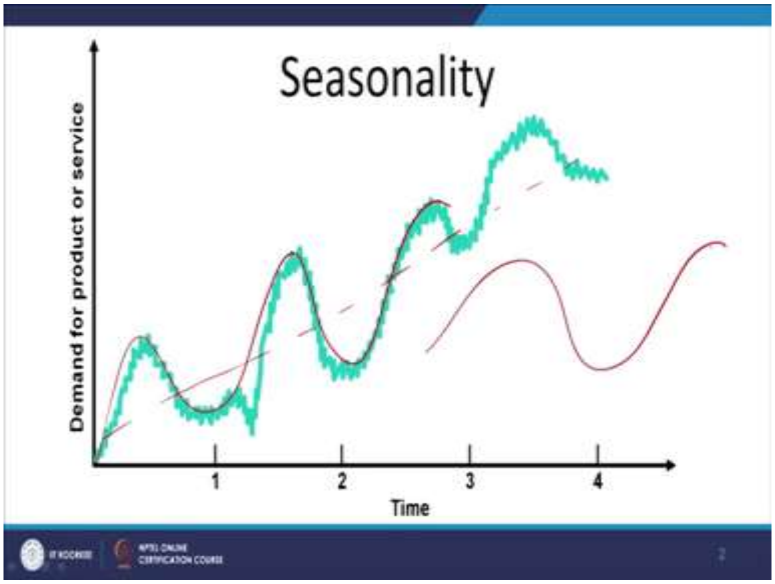

Like say, as a function of the time, demand for a product or a service may change significantly, it may go like this. So here although there is a some kind of the trend component, but there can be cyclic variation even without any trend factor. So when there is a seasonal aspect what we can do for determining the forecasting.

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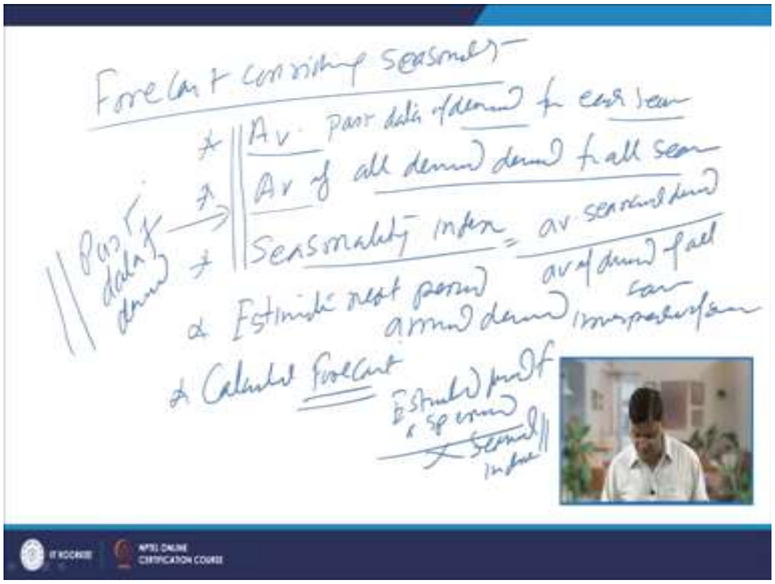

So, basically, there are certain steps which are followed for calculating the forecast considering the seasonality. So, the first step is to calculate the average past data of demand for each season. Then calculate the average of all demand data for all seasons. So, one is the average demand for each season separately and then average demand of all seasons. These are the two things which are done and based on this we try to calculate the seasonality index, means what will it the extent of influence of season on the demand if there is a particular forecast.

So then, so this is done basically on the basis of the average seasonal demand for that particular season divide by average of demand of all seasons or overall demand, average of the overall demand for all seasons which is available. This may be greater than 1, this may be less than 1 as per the case. So, and then the next one is to estimate, so this, these three calculations are based on the past data of demand.

So obviously, we need the historical demand data and then estimate the next period's annual demand irrespective of the seasons, this is done irrespective of seasons. Then, now we will be, then we calculate the forecast using the estimated demand and the seasonality index. So estimated demand for a specific period multiplied by the seasonal index or seasonality factor which has been calculated.

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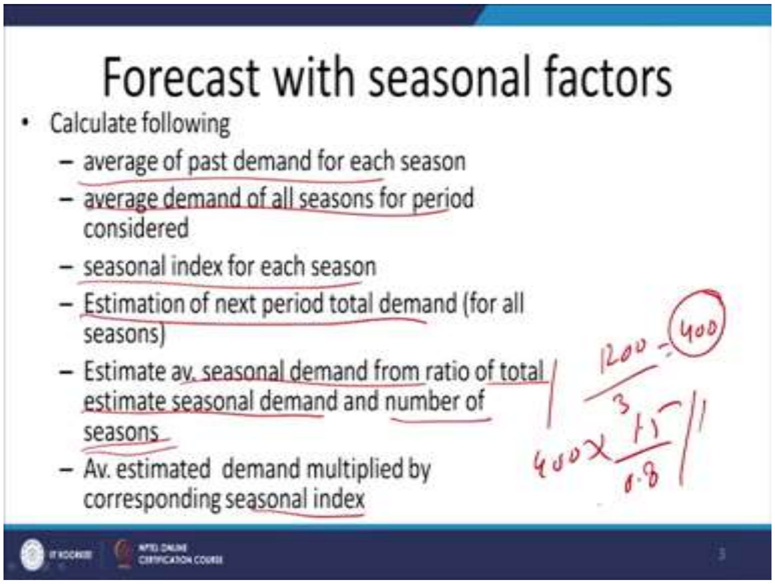

So this is what is done to consider the, to determine the forecast using the seasonal factors. So this has been written like average of the past demand data for each season, the average demand of all seasons for period being considered, then seasonal index calculation for each season, then estimate the demand for the, to estimate the next period total demand for all seasons or irrespective of seasons.

Then estimate the average seasonal demand from the ratio of total estimated seasonal demand and the number of seasons. And then average estimated demand is multiplied by the seasonality index. So basically this is estimated average demand for that particular season multiplied by the seasonal index. That is what is done.

Say, annual demand is 1200 for irrespective of the seasons and then a number of seasons are 3, so the 400 will be the demand, estimated demand for each season. And if you have got the seasonality index, then this 400 multiplied by seasonality index like 1.5 or 0.8 accordingly, according to the seasons we will have the estimated forecast or the forecast for the different periods. Now considering this, we will take up the example.

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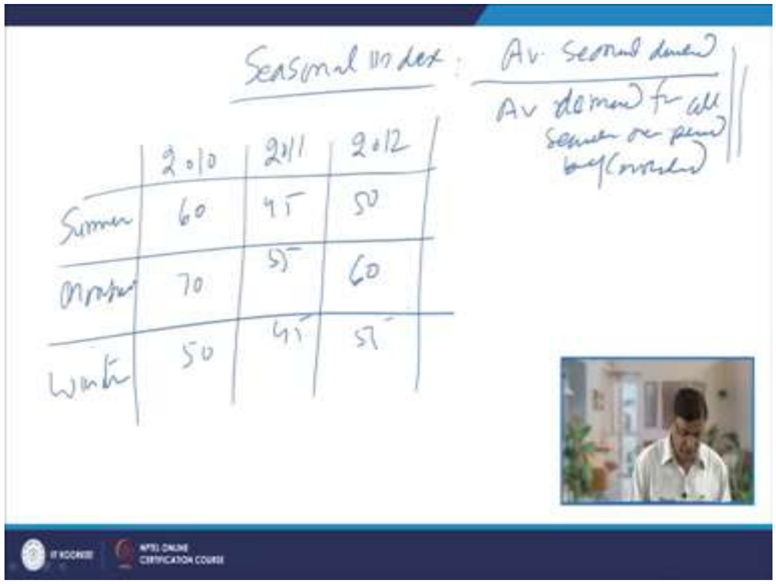

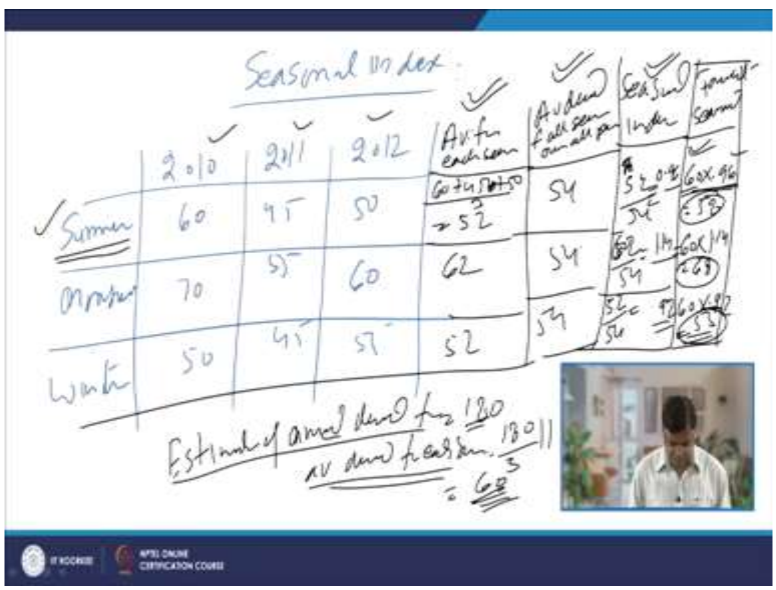

The first thing is seasonal index calculation. So what we have to do first? Average seasonal demand for a given period like say, in a, in a block of 3 years, in a block of 5 years or in a block of 6 months depending up on the seasons, divide by the average demand for all seasons over period being considered. So, let us say, we have 3 periods, 2010, 2011 and 2012, 3 year's data and 3 seasons, summer, monsoon and winter.

Say there is a, there is a demand data for 3 years and 3 seasons say 60, 70 and 50, 2010, 45, 55, 45, 50, 60 and 55. Now what we have to do is, we have to calculate the, now we have to calculate the various parameters needed for calculation of the seasonal index and determining the forecast considering the, considering the seasonal factor.

So, average for each season. Average for each season, so here, average of 3 years, average of demand for 3 years during the summer is say 60 plus 45 plus 50 divide by 3, so this will give us 52. Likewise, we can calculate the average seasonal demand for monsoon, say it is 62 and for winter, say it is 50 based on the calculation that is what we can determine.

And then overall average, average demand for all seasons over all periods which are being considered so average seasonal, average demand for all 3 seasons of all 3 years that will give us say, 54. That will be same for all. Now what we have to do, we have to calculate the seasonal index.

Seasonal index is calculated based on the average demand for that, for each season divided by the over average of the overall demand for all seasons over a period of, over the period which is being considered. So here, 52 divide by 54 (54) 62 divided by 54, seasonal index for monsoon and for winter it is 52 divided by 54. So, this is how we will be getting the seasonal index. For summer, it is 0.96, for monsoon it is 1.14 and for winter it is 0.92.

Now, let us say, let us say estimated, estimation of the annual demand for the next period is 180, which means there are, since there are 3 seasons so, average demand for each season will be 180 divided by 3 that will be the 60. So, considering the seasonal index, the demand for a particular season, let us say, the demand for summer, 60 multiplied by 0.96, so average demand for that particular average, estimated demand for a particular season that is 60 into the seasonal index for that particular season that is 9.96.

Similarly, for monsoon, the average estimated demand for monsoon is 60 and the seasonality factor is (point) 1.14. Similarly for winter, it is, average estimated demand for winter is 60 and the seasonality index is 0.92. So, now we can calculate, here it will be 58, here it will be 68 and here it will be 55. So this is how we will be calculating the, the forecast considering the seasonal factor.

So here, what we are doing, we are considering the different seasons, like say in simplest form it is summer, monsoon and winter. Demand data for 3 years, then determination of the average demand for each season, then overall average demand for all seasons and then calculation of the seasonal index and then estimation of the average demand for, average annual demand for the next period, and then, average demand for each season, since there are 3 seasons, so, 180 divided by 3, giving us the estimated demand for each season (160), sorry 60.

And then this estimated, so this is basically forecast considering the seasonality. So here, the estimated demand multiplied by the seasonal factor, this will give us the forecast considering the seasonal factor. Now, this is what we have talked.

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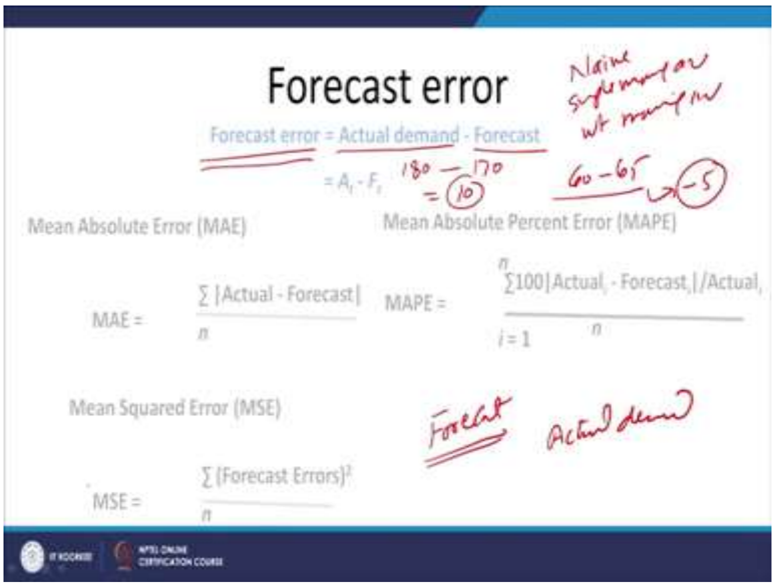

Now, another important thing is since there have, we have talked about the different methods of calculating the forecasting like naive method, simple moving average method, weighted moving average method, then we have talked simple exponentially smoothing method, exponentially smoothing with the trend, forecasting using the seasonal factors.

So, we have got the forecast using the different methods and based on the actual performance of product and service, we have, we get the data of the actual demand. So now, to check how accurately and how much deviation is there in forecast from the actual demand, we need to calculate the forecasting errors.

So the forecast error is determined on the basis of the actual demand and the forecast difference. If the actual demand is more and forecast is less, then the forecast error will be positive, 10. And if it is vice versa, like the forecast actual demand is 60, forecast was 65 then the forecast error will be of the minus 5. So there can be various situations where we consider the sign and we do not consider the sign.

So when we do not consider the sign whether it, the difference is a positive or a negative, then accordingly, we calculate, accordingly, we give the different terms to the forecasting errors and accordingly we have the different methods of calculating the forecasting error.

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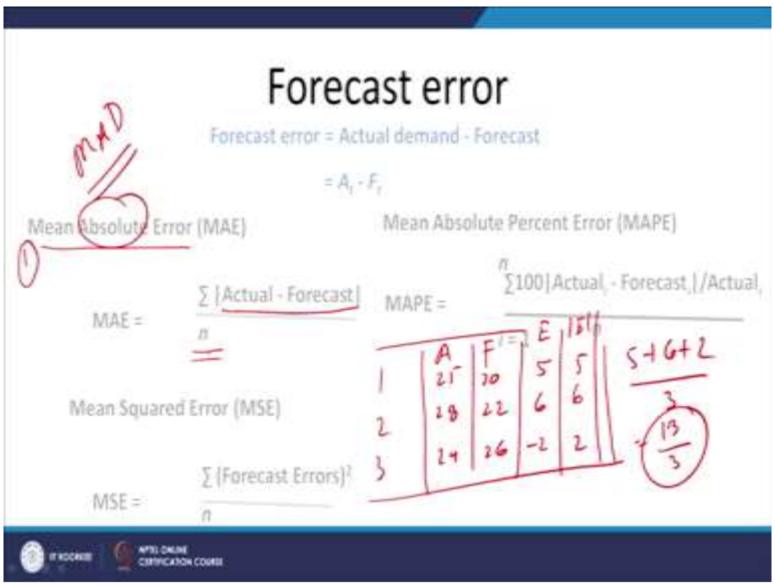

Now, like say, there are three methods have been expressed here. One is the Mean Absolute Error or Mean Absolute Deviation, MAD is very commonly used word. So, in this case, we have the word absolute means we do not consider the sign, whatever is the difference, we for the different situations, for different periods, we just average of all those values is taken. Just for an example here, if the actual demand and the forecast data for the 3 periods, 1, 2, 3 it is given like 25, 20, 28, 22 and 24, 26. So here if we consider just the, that error, the forecast error, then it will be like 5, 6 and minus 2.

So here, if we just overlook the sign of this difference, then, absolute error or absolute deviation will be just 5, 6 and 2. So if we have to determine, for these 3 periods, if we want to determine the mean absolute deviation, then mean deviation for these 3 periods will be like 5 plus 6 plus 2 divided by 3. So here, 13 by 3, this will give us the mean absolute deviation. So, like sum of the all errors divided by the number of periods for which error is being considered.

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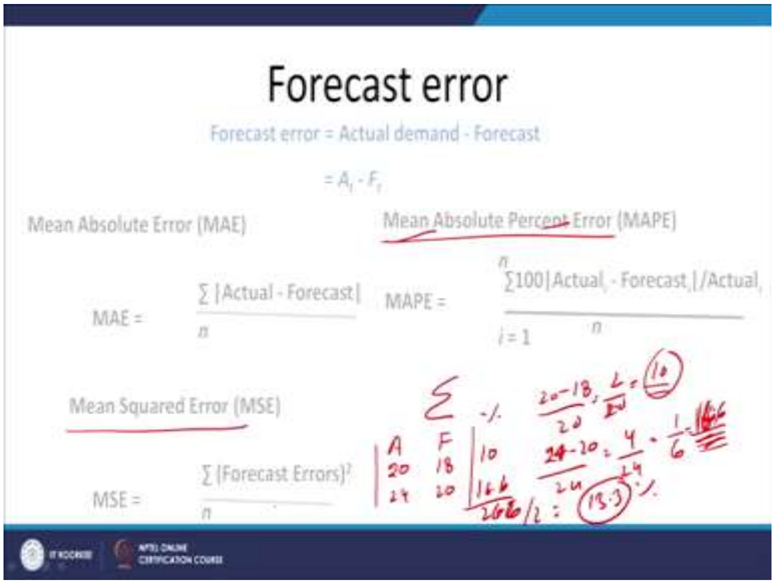

Then there is another way, wherein we use the percentage, where we use the percentage, like mean absolute percentage error. So, in that case, we basically again calculate the sum of the all these percentages in terms of the error. Like say, if we have the data of the actual data of the demand and forecast is like say, actual is 20 and 18, 24 and 20 like say, this is the two data values.

So to determine the percentage error in these two cases, like say, the actual and forecast, so 20 minus 18 divided by 20. So 2 divided by 20. So means, there is a error of 10 percent. On the other hand, for the second case, 24 minus 20 divide by 24, so 4 divide by 24, 1 by 6, so here, let us say, it will be, so here if we determine, 16.66 percent will be the kind of error. So, if we have the two data values like 10 and 16.6, so the sum of these, sum of these two will be 26.6 and average of these two, average percentage error will be like 13.3.

So, mean absolute percentage error, this is how we can get. On the other hand, the mean squared error, where we calculate the sum of square of errors, average of the square of errors. So here, we will take another simple example.

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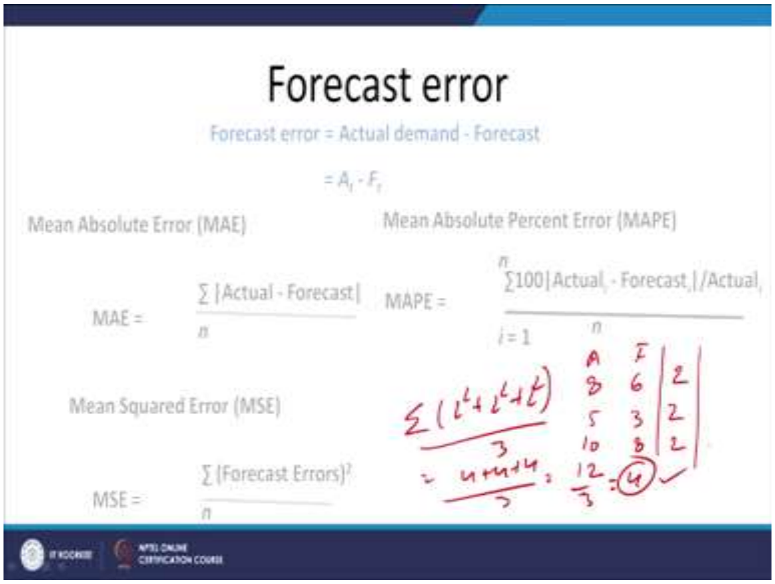

Let us take the forecast actual demand and the forecast 8, 6, 5, 3, 10, 8. So the error is like 2, 2 and 2. So what we have to do is sum of errors, square of all these errors, so 2 square plus 2 square plus 2 square divide by 3. So here, what we will have, the 4 plus 4 plus 4 divided by 3, that will be 12 by 3, so here it will be 4. Sum of the mean squared error will be 4, this is how we can do it for forecasting errors.

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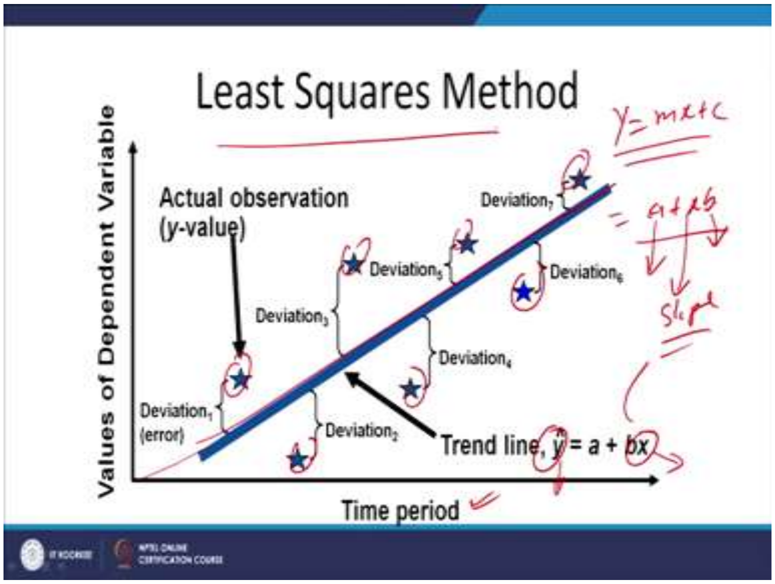

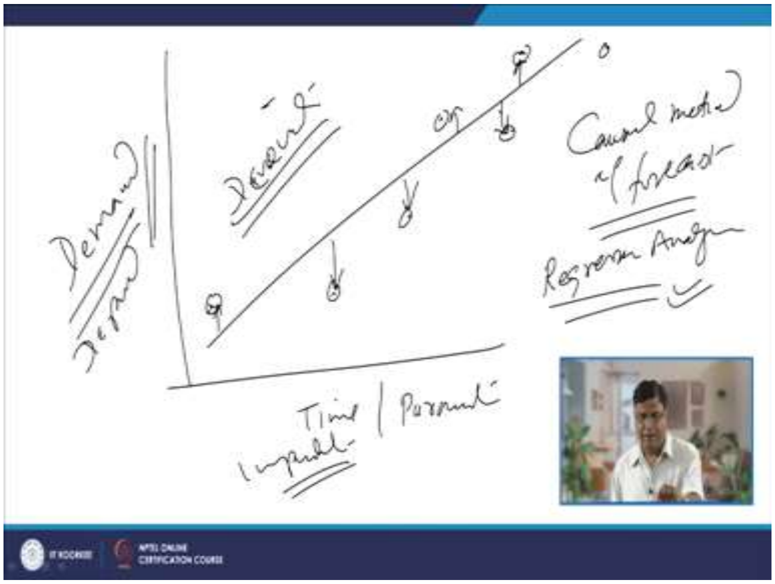

Now, this is the another method wherein I will give, the brief of this, let us say, we have got the past demand data and thus, demand data is as a function of either time or some unique independent variable or parameter, maybe quarter, or maybe some other variable, which can be related with the demand, and the demand is showing some kind of the variation.

Like say, because these will be there in form of scatter points, like this. So it is not necessarily falling in a particular way but it is showing some kind of the trend. So how to, this is called casual method of forecasting, casual method of forecasting where the relationship between the, the demand and some independent variable is established.

So what we try to do, or demand of the parameter of the interest is related with the, like dependent parameter is related with the independent parameter using some relationship. So how to develop that relationship using the suitable regression analysis. So here, if we see, if there is a trend of this kind, then with respect to this trend line, there is a deviation in the values of this much, of this much, of this much, of this much, of this much.

So here, with respect to this, the trend line, like we have got so many data points and we are trying to fit it with some line and who so, obviously all these points will be falling here and there, so these we can say as a deviation. So to establish a relationship between the dependent variables and independent variables, we need to have some kind of the relationship and for that, we do the regression analysis.

So here, like say the value of the dependent variable and independent variable is kept here and this is showing just kind of the trend or the, the way by which the data is changing and here, it is showing the different data points and corresponding deviations. So, like say, this trend line, is a simple, it is just like y is equal to m x plus c. It is similar to that. So here, a plus x b. So here, basically, a is the intercept on the y-axis of this line, b is the another coefficient and x is the slope.

So here, basically, we will try to (calcula) x is the, basically x and y are, y is the dependent variable and x is the independent variable and b and a are the coefficients which are calculated in this method to establish the kind of relationship between the dependent and independent variables using least square method.

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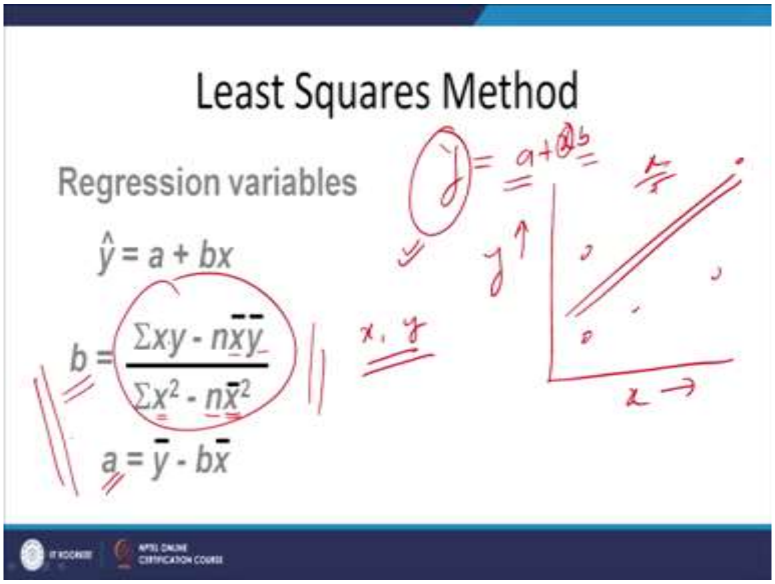

So, regression variables in the regression equation which is like simple, y is equal to a plus x b. So, a and b are calculated, x is the independent variable and y is the dependent variable. So how to calculate, how to calculate the value of these coefficients, so we know, or we can estimate, we can determine the kind of the value of the y which will be related with the independent variable x.

So if we have the x value, we can get the value of y using this kind of equation. So here, to calculate the b, we need to calculate the two coefficients a and b, and b is calculated using this kind of equation, sum of x into b, n is the number of the parameters that are being considered, x bar is the average of the x, y bar is the average of the y, x square, sum of all x square values, number of values, n is the number of the parameters which are being considered and x bar is x bar square.

So this is how it is done, so here, say here x in the x-axis and y in the y-axis, and we have got the different data point values which, and these values are known, we are just trying to find the way by which it can be related, x can be related with the y. So, for that, we need to consider an example where we have, we will be using the different values of x and y from the past data record and then those will be used to calculate the value of a and b to determine this, the coefficient of this equation, y is equal to a plus x b.

This equation, I will be giving in the next presentation. Now I will summarize this presentation. In this presentation, basically, I talked about the two aspects, one is how to determine the forecast considering the seasonality factor and what we can do to relate the independent variables with the dependent variables, like the time factor can be related with the demand to see how to get the forecast. So the examples related with this, I will be talking in the next presentation. Thank you for your attention.