Engineering Econometrics
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Lecture – 05
Introduction to Engineering Econometrics (Contd.)

Hello everybody, this is Rudra Pradhan here. Welcome to Engineering Econometrics and today we will start our 5th lecture that is the unit of Introduction to Engineering Econometrics. And today we specifically highlight the forecasting issue, in fact, in the last lecture we have discussed details about the engineering econometrics the kind of you know requirement, the kind of you know structure in the way we will analyze the problems and then discuss the issues and point out the objectives and the kind of you know insight we are expecting.

And the end part of this particular process is nothing but called as a predictions and followed by forecasting. So, we should know little bit about forecasting before we solve any kind of you know engineering problems as per the particular requirement.

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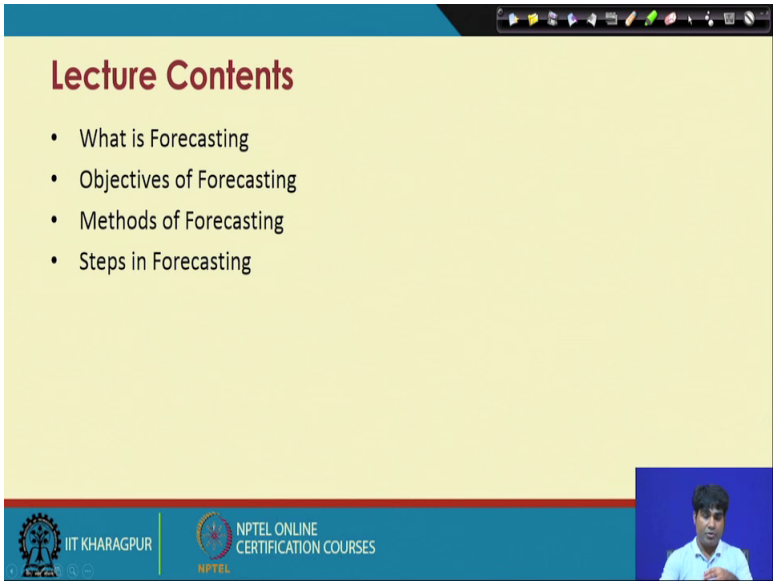

So, let us start with the you know basic or contents about this lectures. So, first of all, what is all about forecasting, and then we will discuss something related to objectives, methods, and then steps of you know forecastings, so how to start the particular process, and then how to conclude with the kind of you know requirements.

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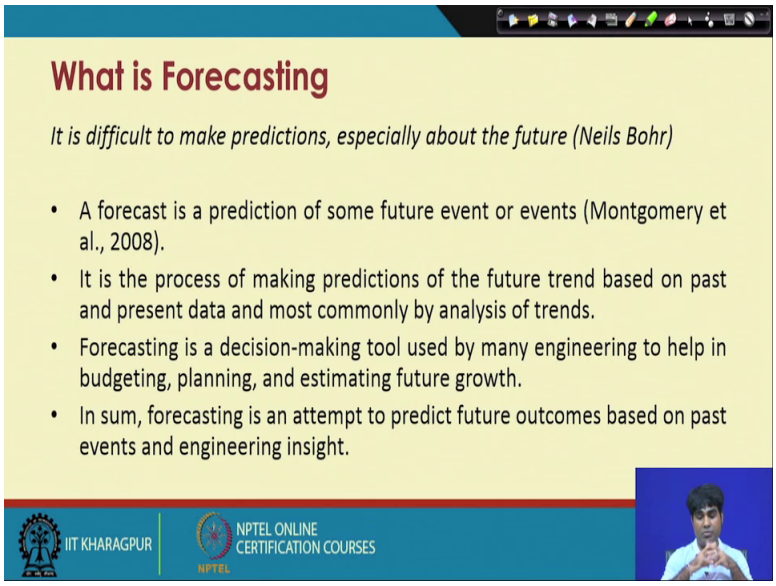

So, there are you know there are n number of ways we can define the term forecasting. And specifically a you know, it is a kind of you know difficult and complex terms so without any kind of you know quantitative structure or something like you know highly qualitative structure, you cannot do some you know do something called as you know forecastings. So, let us see, how is the kind of you know forecasting all togethers, and what are the steps we have to follow to do the forecasting for a particular you know engineering problems.

So, typically it is a you know comparatively said difficult to make predictions, especially about the future. So, forecastings comes into the you know lime light. And a forecast is a prediction of some future events, or the events which you need a actually to you know justify the facts for the growth or something kind of you know the sustainability aspects of you know any kind of you know engineering problems. In fact, it is the process of making predictions of the future trend based on the past and present data, and most commonly by analysis of trends.

So, there are different labels of you know structuring. What we have discussed earlier the kind of you know engineering econometrics can be of you know two types, you know something called as you know descriptive econometrics, and then we have something called as you know predictive econometrics. So, in both the cases, it is the question of you know use of data and typically we have already discussed the kind of you know data,

the kind of you know you know process the data structure is like that you know we may have a cross-sectional type, we may have a time series type, then we may have you know the club of these two called as a pool data or you know panel data.

And in fact, whatever ways we can represent the data, or you know gather the data for the kind of you know investigation about a engineering problem with the intension of you know prediction, and the future forecasting so the issue is that you know, we technically use the past data the past information and the kind of you know present data present information. With the help of fast and present data, we like to predict the future requirement, so that is the basic background of about the forecasting. So, what are the ways we will use the past data and present data, and then predict the future requirement, so that is the kind of you know learning, which will help from the structure of you know forecastings.

So, let us see how is the kind of you know forecasting. So, a in some forecasting is a kind of you know decision-making tool used by many engineering problems to help in budgeting, planning, and estimating future growth. So, whatever may be the kind of you know problem area or any kind of you know engineering. So, ultimately you can like to investigate, then you know the major requirement for instance you know typically the kind of you know engineering econometrics requirement, what should be the sustainability aspects all together, and then forecasting come into the picture.

So, we will see how is this you know structure of you know past structure all together, and the present structure. And with the help of past and present, we have to build the future path. So, this is the basic requirement. And sometimes it can be you know called as an attempt to predict future outcomes based on past events, and the kind of you know engineering insight. So, if you summarize all together, then it is nothing but you know look into the past information, present information, and see what should be the trend for the future requirement.

So, whatever may be the problem, so we have to do the kind of you know forecasting for the future requirement. So, the kind of you know forecasting may be very simple, may be very complex, it depends upon the you know nature of the problem. For instance, the nature of problem may be may be very complex, or may be very simple. For instance, it may be a bivariate structure, it may be a trivariate structure, it may be a multivariate

structure. So, if it is a you know univariate or bivariate structure, it is very easy to do the kind of you know prediction and forecasting.

But, in the case of you know multivariate problems, it is not so easy to do you know forecasting a you know very easily in fact. So, in that context, some kind of you know quantitative structure, or the kind of you know you know technical procedure you have to follow to do the better forecasting as per the future requirement.

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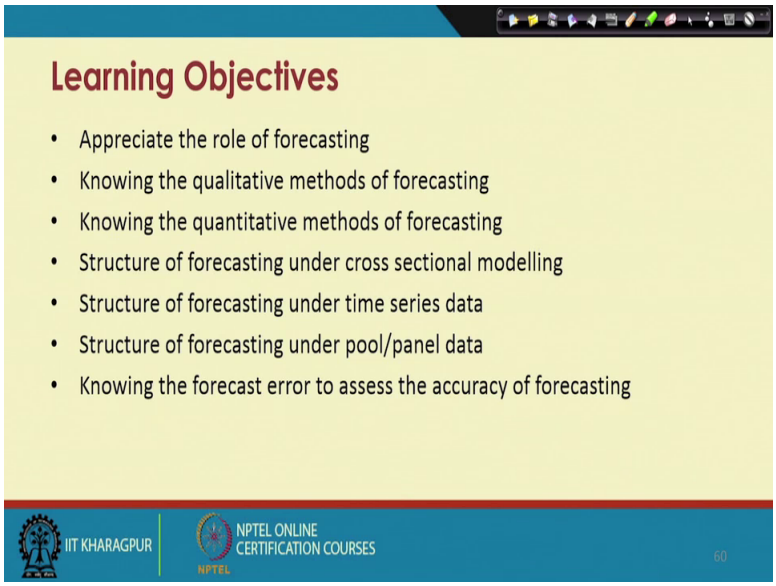

So, in that context let us see, how is the kind you know requirement. So, the basic key requirement of you know means, basic objectives (Refer Time: 07:09) this forecasting is to fix the appropriate the rule of forecasting; and knowing the qualitative methods of forecasting and knowing the quantitative methods of forecasting.

Then we have to know the structure of forecasting under cross-sectional modeling. Again we like to know the structure of forecasting under time series a time series data time series involving. Similarly, in the case of pool data, and you know panel data the kind you know forecasting rule. So, at the end, we like to know the forecasting error, how to access the forecastings, and then we like to see the accuracy of the forecasting, so that means all together it depends upon the kind of you know data structure all together.

So, if you have a cross-sectional data, what is the kind of you know forecasting you know rule. So, if it is a time series, what is the kind of you know forecasting rule. Again

in the kind of you know pool or panel the nature of forecasting you know rule. So, ultimately a in each case, we have some kind of you know strategy to measure the accuracy of you know forecasting. So, there are certain tools, which can you know justify whether the particular forecasting with the help of you know past data and present data are perfect or not. So, the accuracy level will help you lot to know the in a the proper structure of you know forecasting, or whether good forecasting you can say. So, how is the particular structures we can get to knowing details here.

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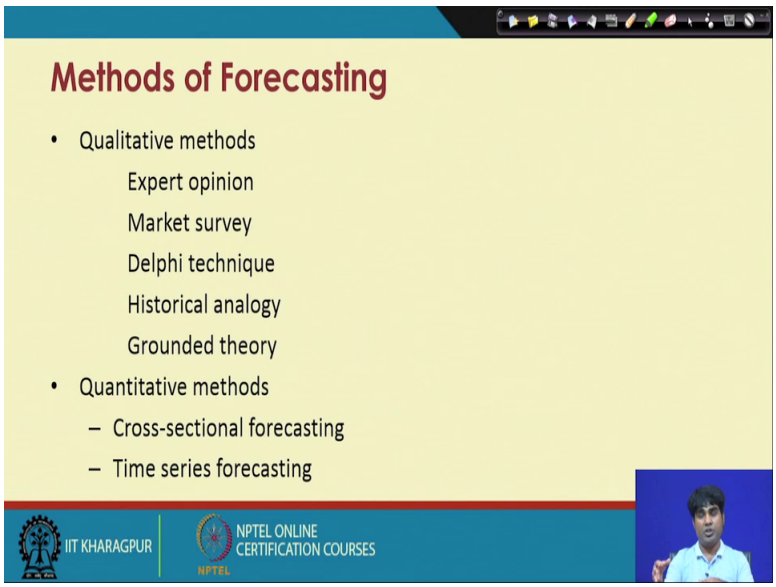

So, so far as a you know we all together you know get to know the kind of you know forecastings in the contest of you know data structure. But, ultimately how is the kind of you know forecasting, it depends upon the kind of you know methods, and the kind of you know problem structure. For instance, if a particular problem is a very structures, you know the decision variables are identified the you know data are you know already available against each decision variables. Then it is somehow you know very easy to do the forecasting, and then you can measure the forecasting accuracy, and finally fix the forecasting structure. But, sometimes some of the engineering problems is so complex, or you know something like that.

So, you may not know, what are the exact decision variable through, which you do the forecasting. And sometimes you may know, you may actually know the decision variable structure. But, unfortunately you may not have a information to read the pattern, and then

do the kind of you know forecasting, so that is how in the methodological you know so far in methodological structure is concerned, we have a two different you know methods, one is called as a qualitative methods of forecastings, another is called as a quantitative methods of forecastings.

So, we have a couple of you know methods under qualitative structure, and we have a couple of methods under quantitative structure. In fact, quantitative structures you need you know Harcourt mathematics and statistics to do the kind you know forecasting, and that to on the basis of you know past data and present data. But, in the case of qualitative forecastings, we may not have actually a clear cut past data or past information, and sometimes you may not have the understanding about the decision variables. What are the decision variables, through which you can do the kind of you know forecasting as per the particular you know engineering requirement.

But, both the problems are you know different, and the situation it is a it is completely you know situational aspect. And depending upon the kind of you know problem, depending upon the kind of you know situations. So, you have to apply a particular methodology, and then do the kind of you know forecasting.

So, technically as a engineering students you should know, what are the methods under the qualitative sides, and what are the methods under you know quantitative sides. So, in the case of qualitative side, you may not have a proper information, so the first hand idea is to have the proper information through a particular you know mechanism, and then you have to follow the path of you know forecasting.

But, in the kind of you know quantitative methods, so assuming that you know everything is in a structured way, so that means, the decision variables are known to you, the informations are readily available, then what is a you know means what are you supposed to do is, you know you have to just pickup a particular you know technique, and then on the basis of you know data and the decision variables, then you do the data kind of you know forecastings.

So, let us see, what are the methods under the qualitative structure, and what are the methods under you know quantitative structure. So, far as a qualitative methods are concerned, the first structure is called as a expert opinion, and then we have market survey, again third method is called as a Delphi technique , and forth method is called as

a historical analogy, and then the last but not the least called as you know grounded theory.

In all the all the cases you know this it is completely you know more you know situation, where decision variables, may be decision variables are unknown, if decision variables are unknown, then forget about the kind of you know information requirement. And in the second case you may have the structure of you know decision variable, but the informations are not you know available to you.

So, what is happening means you know in general, qualitative methods of forecasting is a situation, where you do not know how to analyze this particular you know engineering problem, and do the kind of you know forecasting. So, what will you do, you put this kind of you know engineering problem in front of you know group of experts, or you know group of you know persons, who have a excellent knowledge and this aspect. And then, ask to you know ask them to discuss each other.

And on the discussion mode you can pick up some of the you know components, which can be you know in future can be treated as the route making for the decision variables. Then once you know the decision variables on the basis of their you know discussion, then you think about the kind of you know collection means, information collection behind this you know decision variables.

So, most of instance says in the qualitative case, decision variables are not known. So, with the help of experts, and with the help of you know knowing persons, we can get some kind of you know informations, which can be treated as a decision variable, and to analyze the engineering problems and do the kind of you know forecasting.

So, whether it is a kind of you know market survey methods, or Delphi technique, or historical analogy, or the kind of you know grounded theory more or less the mechanisms are you know very much same. So, it is you to discuss among the groups, and then find out what are the decision variable, through which you can analyze the engineering problems, and then do the kind of you know forecastings.

But, in the context of you know quantity methods, we have you know different methods all together. So, we have the cross-sectional kind of you know forecasting, and time series kind of you know forecasting depending upon the a data availability for the kind of

you know decision variables. In simple language, in the case of qualitative structure, so the decision variables and the informations are not readily available. But, in the case of quantitative methods, decision variables and informations are readily available.

In one situation, if decision variables and information are not available, how to handle the situation to solve the engineering problem, and do the forecasting. And in another situation your decision variables are known, and informations are availables, then you have to find out you know what are the technique, which you analyze the problem, and then do the kind of you know you know forecastings.

So, technically if you club these two, you start with the kind of you know things you know like that. Sometimes some of the engineering problems like that you know you can follow the first qualitative pattern, then you can move in to the quantitative patterns, because in the qualitative pattern you may not have information, you to gather information, and do the forecasting. And in the in the later stage, you have a decision variable information, and the kind of you know data, then you do the kind of you know forecasting.

So, this the understanding is like that you know if you have not decision variables, you cannot have the data. And once you have decision variable, and you have the data, then you can do the forecasting, but you can do better forecasting. If you know something you know more kind of you know structure or more non techniques, through which with the help of you know technique, you can do better forecasting, because when your problem is very complicated, and very complex.

It is not so easy to do the forecasting manually, or you know simple way of you know doing the structuring or restructuring to come with a kind of you know solution, which can address here you know engineering problem, so that is how it is better to know both the qualitative structure and quantitative structure, and do the kind of you know forecasting as per the requirement of particular engineering problem.

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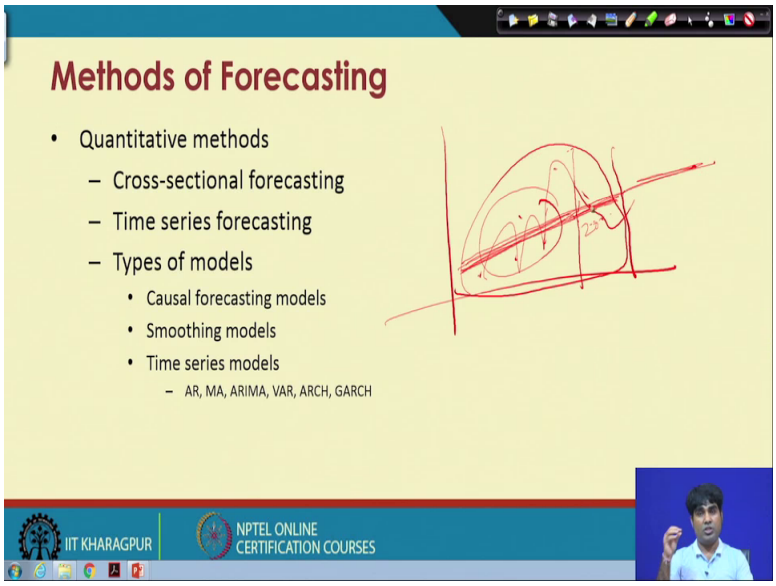

And now let us you know go with you know kind of you know methods of forecasting. And in the methods of forecasting, what we have already discussed, it is kind of you know qualitative structure. But these methods are specifically under the quantitative structure. In the case of you know qualitative structure, there is a no strong mechanisms or strong techniques, through which we will do the forecasting.

It is the kind of you know discussion modes, something related to group discussion. And then on the basis of you know discussion, you to come with some kind of you know decision variables informations. And the kind of you know information, you can gather among the decision variables, and then address the engineering problems, and do the forecasting as per the particular you know requirement.

But the Harcourt task is a to know the techniques as in the quantitative methods. So, here some of the techniques are very simple, and some of the techniques are you know very complex. So, again you should know, but the simple techniques, and both the complex techniques, in order to address the particular engineering problems, because knowing the simple, and you know complex, you know you may be in a position to pick up, which particular technique is very useful for addressing the engineering problem.

So, in the one side you know the kind of you know division is a cross-sectional forecasting, and times reach forecasting depending upon the data structure or you know data availability. And then so far as a times types of you know models are concerned, so

we have a casualty forecasting models, and then smoothing models, and then finally, we have a time series models.

In fact, under the time series models or the time series model of you know forecasting is very interesting, very complex, and you know very top sometimes you can say. For instance, some of the models are you know or some of the techniques are very simple one, and some of the techniques are you know very complex one. It is sometimes you know without any mathematical strong mathematical knowledge, or statistical knowledge, you may not understand this technique, and you may not use this technique.

For instance, under the time series modeling, so you have a called as you know scheme called as a autoregressive schemes, you have a moving average scheme, again we have the club of these two that is called as you know autoregressive integrated, moving average scheme, vector auto regressive schemes. Then there are schemes called as you know volatility modeling like you know autoregressive conditional residue, generalize auto regressive conditional (Refer Time: 19:40) so that means, what I can say that you know under the time series modeling. So, there are so many you know simple techniques or advanced techniques to do the kind of you know forecasting.

And you know very simple you know understanding is that you know, in the case of you know time series data, the way of forecasting is the you know very easy, and you know it is more appropriate in fact, you can say, because it maintains a kind of you know continuity.

For instance let us say, monthly data is available from you know 2000 to 2000 to 2015, and then you need to forecast for you know 2016 and 2017, so that means, you know monthly it is actually, it is in a kind of you know trend you know trend way, then you have just actually read the trend, and then can do the kind of you know forecasting. But, in the case of you know cross-sectional data, it is not so easy, to just to the follow the trend, and then the kind of you know forecasting. Just like you can you can you can just you know read the patterns, and then extend this kind of you know pattern for the future requirement, which is very easy in the case of you know time series data. But, that is not so easy in the case of you know cross-sectional data.

Again after you know doing the forecasting structure, so then you have to check the accuracy. And so for as a accuracy check is concerned, so in the case of you know time

series modeling, it is a very easy to do that. But it not so easy, in the case of you know cross-sectional modeling. For instance, in the case of you know time series modeling, so what about data you can have.

So you can actually divide into two parts, for instance out of you know say 150 data, 80 percent of the data, you can do the model development, and model diagnostic check, and everything you fix for the you know future requirement. Then next 20 percent data, you can you can keep for you know validations, so that means, ultimately when you have actually original data, the label of reporting may not in a kind of you know continuous way, so it may be ups and downs.

For instance, it may be like this you will see. So, let us say it is you know some 100 observations are there. And all observations will be like this. So, you can just you know put a trend like this. So, the now way of forecasting is that you know you apply some kind of you know technique, and then find out a trend line, then the way of forecasting simply is that you know extend this trend line like this. So, now, once you confirm that this trend is a ok, then you can just extend this line up to this mark.

But, now in order to know whether this line is perfect or not, what will we do in reality. So, let us say, this is actually 100 percent of data. So, you make it you know 80 percent for the model building, then the rest 20 percent you can keep or you know model validations, so that means, you read this data develop a model, and find out the trend line, and extend this trend line up to this once. But, actual datas are already available here, then you see the actually trend line, and the that means, it is called as a forecasted line, and the actual you know data points.

So, the forecasted line and the actual data point, if you find there is no big difference, so that means, the accuracy is a very high. So, in that context, so you can you know go ahead with the kind of you know forecasting. And this is much better way to do the forecasting, and it is possible only when you have a time series kind of you know structure.

But, in the case of you know cross-sectional, it is not so easy to check the accuracy of you know forecasting, because the question is the how what kind of you know cross-sectional unit you have to reserve for the accuracy check. But, in the time series, which is possible, because you are a actually moving from extreme past to you know of presents.

So, by default the towards the present data, you can keep or you can you know reserve for the kind of you know accuracy check. So, which is not so easy in the case of you know cross-sectional modeling.

So, that is why, time series data means doing forecasting by using time series data is you know very easy, and very perfect compared to you know cross-sectional. Using cross-sectional data for the kind of you know forecasting, and that to for the engineering requirement, that does not means with the help of forecasted means cross-sectional data, you will not do the you know forecasting or only you know time series data you can do the forecasting. Yes we can do the forecasting under the cross-sectional data, and we can do the forecasting under the time series data.

But, the so far as the accuracy is concerned, the kind of you know sustainability is concerned, so time series can you know give you high accuracy, high sustainability in comparison with the you know cross-sectional data and cross-sectional modeling, so far as you know forecasting is concerned.

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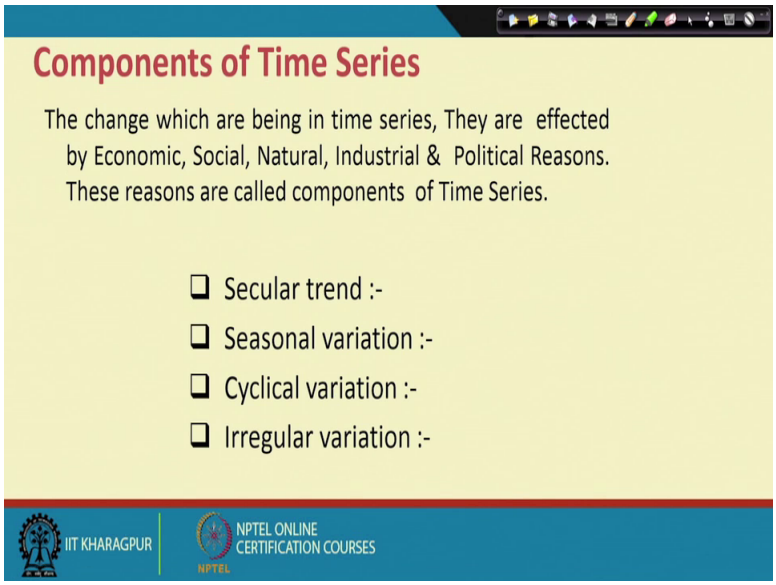

So, now, after knowing all these techniques; so, we will move to the kind of you know structures, so that means, the there are you know many things we are supposed to know under the time series. So, some of the things are called as you know components of you know time series. The here the change, which are being in time series, they are affected by in many factors sometimes, economical factor, social factor, natural factor, industrial

factor, and political factors. So, these regions are called typically called you know a time series components.

And accordingly, we have you know the structure called as you know secular trend, and seasonal variation, cyclical variations, and irregular variations, that means, you know when you are handling time series data. So, since it is actually it is actually you know structure of you know day wise informations, you know week wise information, monthly informations yearly information,.

So, obviously, there are lots of you know ups and downs can happens, and there are specific regions for the for these ups and downs, it may be economical regions; it may be social regions; it may be natural kind of you know affect; it may be industrial affect; it may be political affect. So, accordingly, so the particular you know structure can be divided into four different groups. So, what I have mentioned, called as you know secular trends, seasonal variations, cyclical variations, and irregular variations.

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So, ultimately, so let me give you some kind of you know hint about these four component. So, start starting with you know secular trend, it is the case of you know increase or decrease in the movements of a time series, and that is what called as you know secular trend. A time series that are may so upward trend, or it may so downward trend for a period of years, and this may be due to factors like you know increase in population, increase in demand, change in technological progress, then large scale shift

in consumers supply or you know means, producer supply or consumer demand something like that.

And you know for examples, population increases over a period of time, price increases over a period of years, production of goods on the capital market of the country increases over a period of years. These are the examples of you know upward trend. And similarly, the sales of a commodity may decrease over a period of time, because of you know better product coming to the market. And this is an example of you know declining trend or you know downward trend, so that means, what I haves you know shown you in the last slides.

So, when you actually plot or you know you know fix these points or you know visualize these data, you will find the time series reporting may not be in a kind of you know linear trend. Most of the instances there is a you know means 99 percent instances you will find, they are you know in a kind of you know non non-linearity patterns.

So, we are you know you will find some ups and some downs. And the question is you know you to find out why these ups happens, and why these downs happen, so there is a specific region for that. Otherwise, if there is a no such regions, then there is a high chance that you know the particular pattern can you know follow a linear trend or something like that. So, the beauty of this forecasting is a not only to predict the future requirement, but also to find out you know point out the factors, which can you know cause the uptrend, and which can cause the down trend. So, this is how the kind of you know structure called as you know secular you know secular trend.

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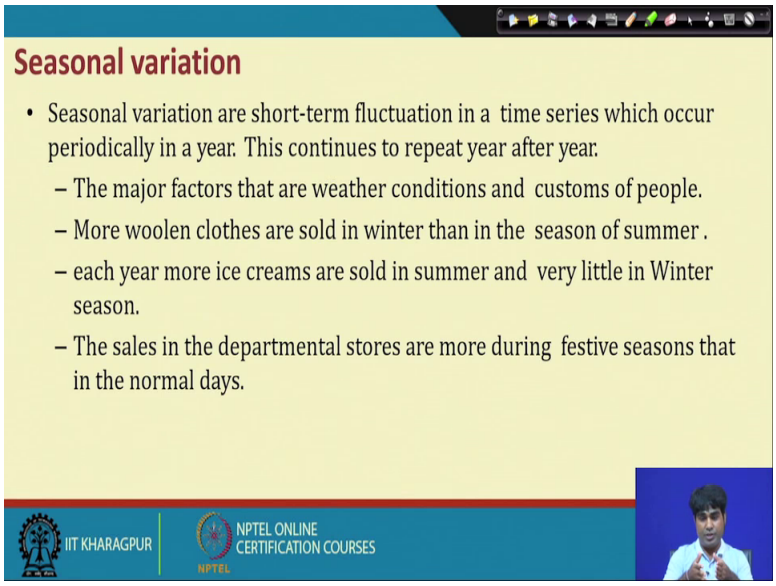

And then we will have a structure called as you know seasonal variation. Since, it is a kind of you know time series data. Let us start with you know annual data. When you will talk about the reporting of you know annual data, it is the sum of you know monthly data, or sum of the weekly data, or sum of the day wise data. So, when you are putting a annual data figure, then if you break, then you will find lots of you know you know monthly kind of you know cluster or seasonal kind of you know cluster.

So, like a like you know in the last slide we can we have pointed out there is a ups and downs. So, here in the kind of you know seasonal breakup, that means, technically if you will go for you know quarterly data, we will find there is again you know ups and downs.

So, this seasonal variations are short-term fluctuations in a time series, which occur periodically in a year, this continues to repeat year after years. The major factors that are you know whether conditions, you know customs of the peoples, like you know woolen cloths during you know in winter seasons, and then you know summer cloths during you know summer times. So, because of this regions you know sometimes you know the these kind of you know sale should be high, then same summer you know summer type of cloths it may be the it may be these in case you know the sales in down, in the case of you know winter time.

So, that means, technically there is a seasonal variation, and it depends upon the type of you know products, the type of you know items, or the kind of you know decision

variables, and depending upon the time and the kind of you know seasonal requirement. So, there is a ups and downs. Against the idea about the time series structure is that you know to find out, what are the factors or the kind of you know seasonality through which these this kind of you know affect is coming to the picture. Until unless you point out all these factors, then you may not do the better forecasting or you cannot get away you know better trend to high light the kind of you know engineering problems.

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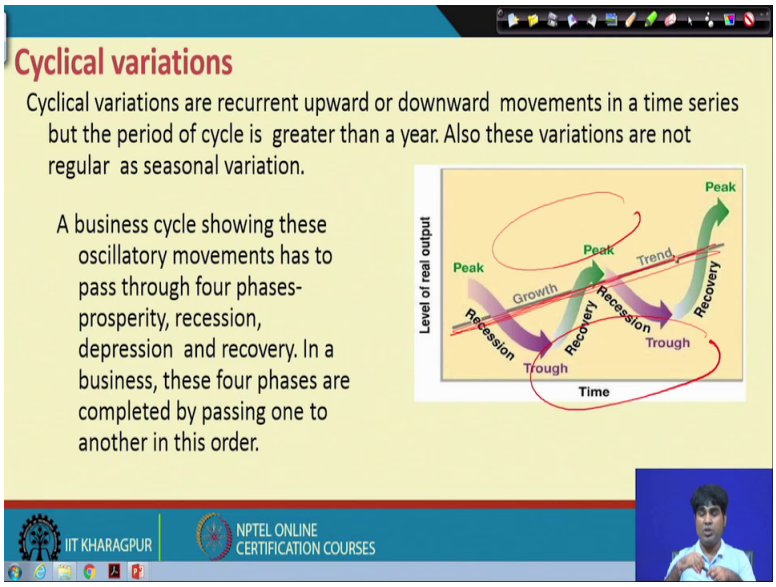

So, then the then the other component is called as you know cyclical variation. In fact, the previous to or something called as you know short-term kind of you know fluctuation. But, here you will find there is a long term kind of you know patterns. So, cyclical variations are you know means, it can give some kind of you know upward or downward movements in a time series, but the period of cycle is greater than a years, so that means, it is actually it is a block wise you know some something you can call as a you know decadal kind of you know changes.

The best cited example you know the census data of you know Indian economics. So, it is a actually decadal recording. So, in the decadal recording, you will find there is issues change happenings within you know 10 years. So, you will find somewhat you know upward, and somewhat downward.

So, that particular change, because of not you know means that cannot be analyze annually. So, that will change in a long term interval, and that too in a 10 years intervals,

because the data collection mechanism is like that. But, it depends the you know problem to problem, the kind of you know reporting to reporting, and the kind of you know requirement to requirement.

So, typically this is the kind of you know structure called as you know business cycle. And it has you know kind of you know ups and downs, and then and the kind of you know structuring. In fact, in this kind of you know problems, and it is a very much actually you know usefuls the kind of you know engineering problems, if you look into the these particular you know figures, you will find.

So, these are all you know up streams, and these are all called as a downstream, and in betweens the line is called as you know trend line that is actually called as a forecasted lines. So, the idea behind this forecasted line is nothing but called you know you build average line all together. And the average line, this is how the regression mechanism can help you to teach, how to get this average line, or trend line, or forecasted line.

And the line, which you can actually build through you know through the econometrics tools, or the engineering econometrics tools. So, it will in such a way, so the if it is a kind of you know data, then 50 percent of the data will be above, and 50 percent of the data will be below. So, as a result, so you can assume that you know the particular line is a you know perfectly fit for the prediction and forecasting, if that is not the case, then this particular line cannot be called as you know best fitted line for the kind of you know forecasting.

So, that is how, we should know some of the techniques, the simple one, and the complex one. And you have to choose that particular technique, which can give you the better forecasting. In such a way, there is no bias at all in the process of the forecasting or the process of taking the trend line as per the particular you know engineering problem requirement. So, now this is a kind of you know situation called as you know seasonal variations.

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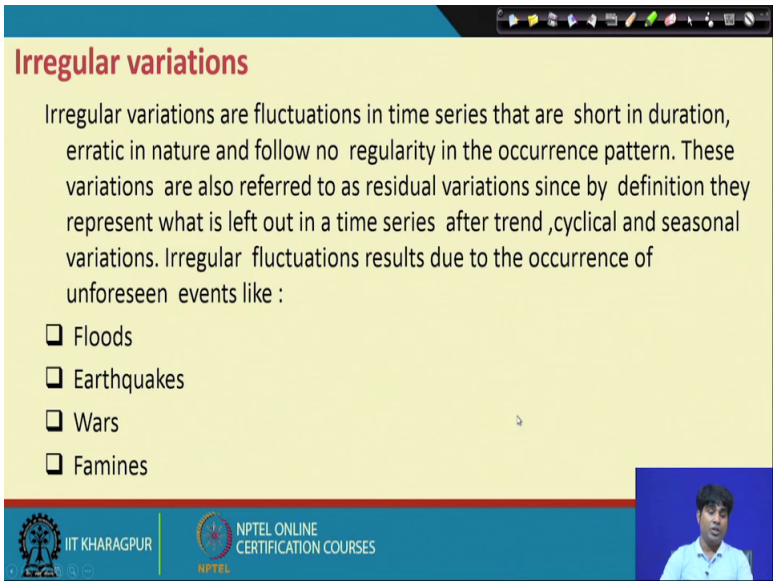

And then we have the kind of you know structure called as you know irregular variations. And it is actually very very long term kind of you know kind of you know scenario, the a fluctuation time that are you know situation where you know you will find the floods, earthquakes, wars. These are all you know major kind of you know events happening in a kind of you know scenario and that is completely you know irregulars not regularly happening.

For instance, let us say seasonality case in a particular year it will definitely occur, there is a 99 percent chance. But the chance of you know flood in a particular year the chance of you know wars in a particular year chance of you know the earthquakes in a particular year, it is a you know it is not so much you know kind of you know mandatory; it may happen, it may not happen. But still you know in the time series analysis or the kind of you know forecasting through a time series data this kind of you know irregularity a need to be checked and then the kind of you know forecasting accuracy can be pointed out.

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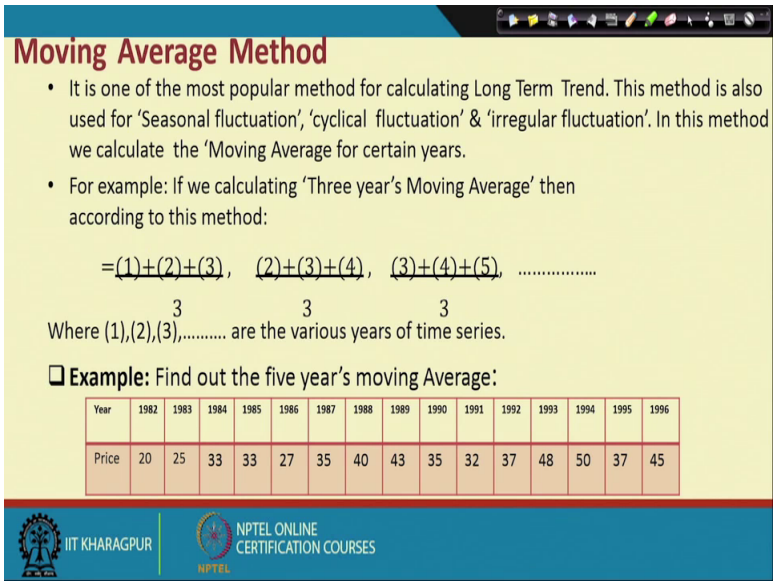

So, there is certain examples are there actually we can use it different mechanisms. For instance, there is a simple or average mechanism is there. So, for instance, there are a you know yearly informations are there for a particular items sales or production something like that. Then you would like to do the forecasting.

So, one of the simple mechanism is called as a moving average mechanisms. You can go for you know three years moving average mechanisms 5 years moving average, 7 years moving average so that means whatever data we have here we have here so you know every 3 years into for instance if you choose three years moving average. So, every 3 years, you find out the average; again a next three years you can find out average; again next 3 years you will find out average. So, likewise now instead of you know joining all these you know actual points you can now you know join the a average points. Then you will find a particular you know trend line so that means, you will do actual plotting and then you will do the plotting through these average.

Then the average plotting is called as a trend line. And the actual plotting is called as you know actual trend. So, the actual trend, and the forecasted trend you like to you know compares. So, you will find, if the trend line forecasted trend line is perfect, then you know some of the items will be above, and some of the items will be below. And by default, the above item and below item, if you will sum, then it will give you the kind of

you know 0 bias; if that is the case this particular you know trend line will be called as you know perfect tool line, and then this will be do the better forecasting.

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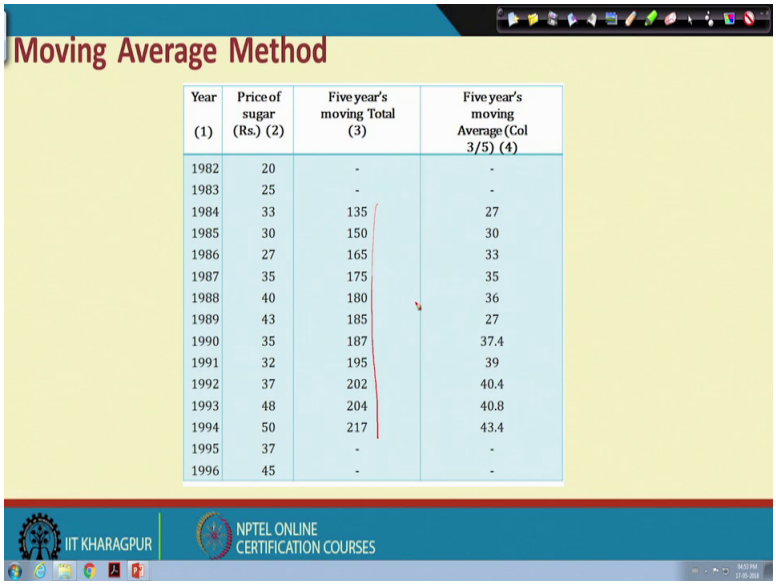

Likewise, likewise we can have a different kind of you know methods to do the forecasting. And this is how the kind of you know moving average mechanism. So, this is the original data. And these are called as a average data. And this is 3 year 5 year moving average, and again you will be go for 3 year moving average, 7 year moving average. So, it is a kind of you know normalization kind of you know structure through which you find out the best fitted line as per the particular you know requirement.

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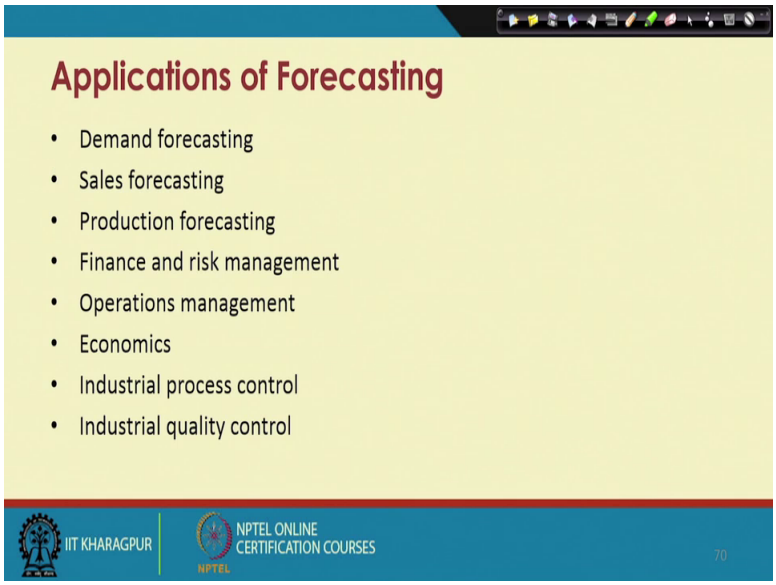

So, for as a application of forecastings are concerned, so you can put you know n number of ways you can you know ready as through, which you do the forecasting. For examples, you can go for demand forecastings, sales forecasting, production forecasting, finance, and risk management forecastings, operations management forecasting, economics forecasting, and then industrial process controls, and industrial quality control. So, these are the area, where you know the use forecasting is a very significant, and we can do these forecasting as per the particular you know engineering problems requirement.

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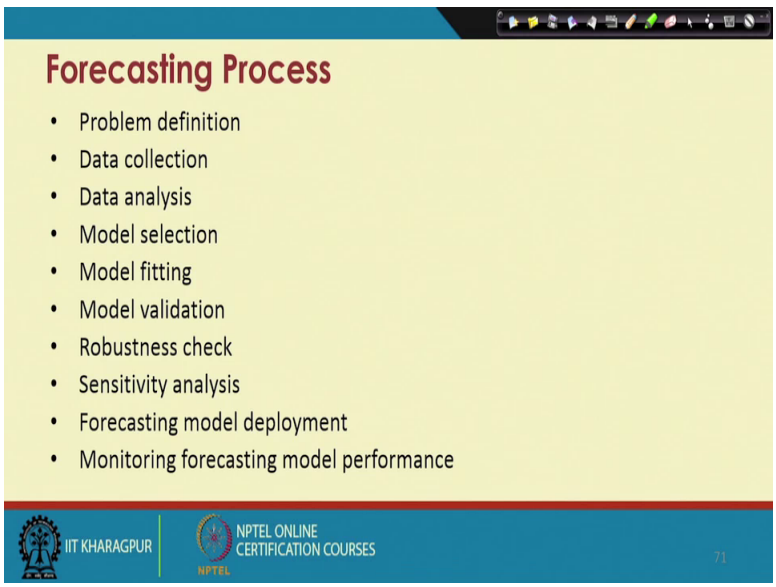

And some of the forecasting process are you know as usually the you know discussions we having the regression modelings. So, you start with you know of problem definitions, data collection, data analysis, model selections, model fitting, model validations, so robustness checks. As are you know means, what we have already discussed that you know these choice of a particular model is a very essential to do the better forecasting.

But, whether the particular model is a best fitted or best choice that we can a check through in a model validations, and some kind of you know a robustness checks and the kind of you know sensitivity analysis. Then finally, once you are you know once you are you know share that you know this model is a perfect that is with respect to both robustness check, and sensitivity check, then you can use this particular model for the forecasting requirement. So, this is how the process about the you know means process about the forecasting. And finally, when you do the forecasting then we can monitor this forecasting as per the particular you know engineering requirement.

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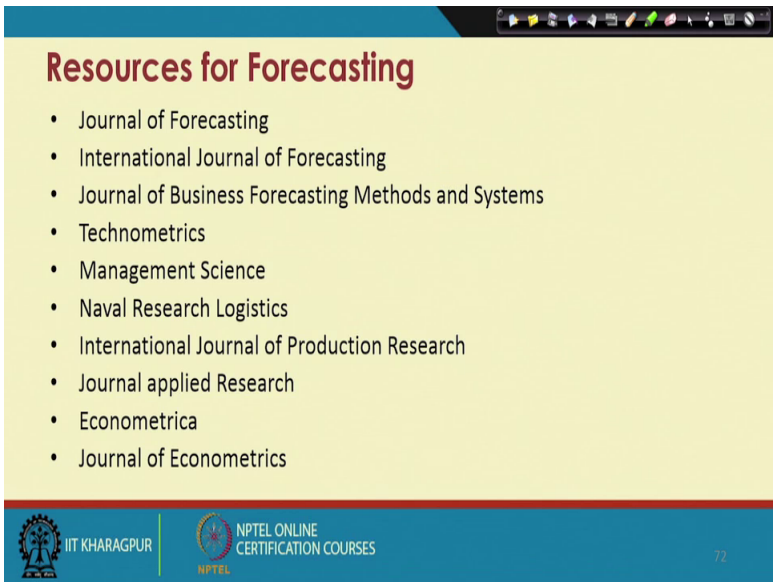

And some of the resources for you know I mean say forecasting that means that to know better way to you know analyze the particular situation, so you can go through you know different journals. And you will find plenty of you know resources or the kind of you know mechanisms through which you do the forecasting, both in a kind of you know cross-sectional framework, and time series framework.

So, some of the sited you know resources, general resources, or journal of forecasting, international journal of forecasting, journal of business forecasting methods and systems, technometrics, management science, naval research logistics, international journal of production research, journal of applied research, and econometrica. So, like these are the classic you know you know journals you know you will find plenty of you know you know resource materials about the forecasting, how to do better forecasting, or how to do you know good forecasting as per the particular you know engineering problems requirement.

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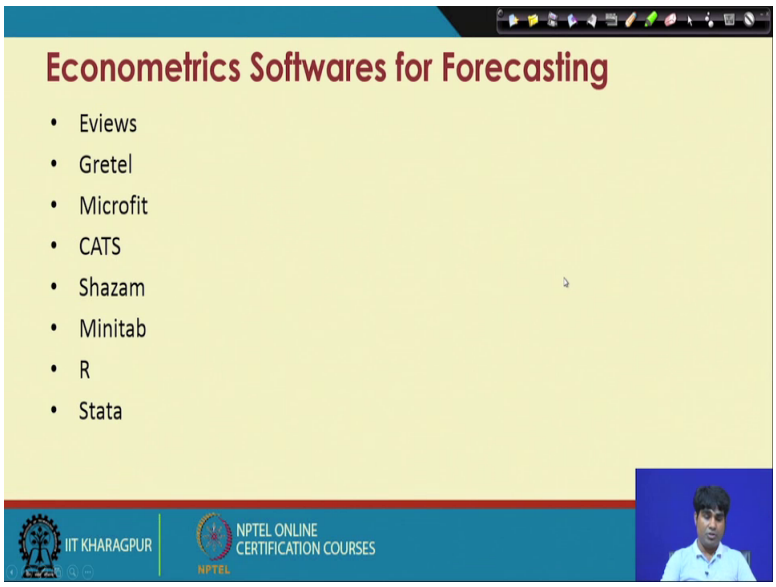

So, with this you know I can tell you the kind of you know structure or forecasting. And by the way when we go for you know forecastings, so the simple mechanism cannot work depending upon the kind of you know complexity of problems or you know data availability, in that case you can use softwares. So, like whatever we have mentioned earlier, some of the econometrics softwares specifically useful for forecasting are you know Eviews, Gretel, Microfit, CATS, Shazams, Minitab, and then R, Stata something like that. So, you can actually do the forecasting accordingly.

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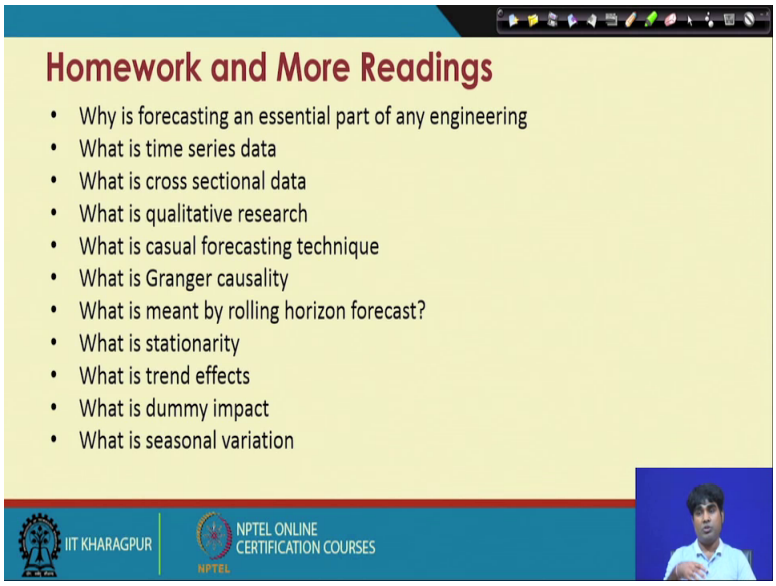

Then some of the homeworks are there. So, the homeworks are you know why is forecasting an essential part of any engineering, why is to very useful for time series data, not so useful for cross sectional data, you know something more about qualitative research, the casual forecasting technique, Granger causality, then stationarity issue, and some of the this is very useful for the kind of you know trend effects, what is dummy impact, seasonal variations. So, these are all very useful for you know future requirement, the kind of you know engineering requirement, where you need actually to do better forecasting, and better predictions. This we will stop here.

Thank you very much.