Six Sigma
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Lecture - 44
Fractional Factorial Design : Minitab Application

Hello friends, hope you are doing well in your personal and professional life. Student must be enjoying their studies and professionals must be progressing well in their respective domain. So, I welcome you once again to our Six Sigma journey and today I would like to demonstrate the application of Minitab for Fractional Factorial Design. We had a detailed discussion in lecture 43 on fractional factorial design and this is the Minitab of application lecture 44.

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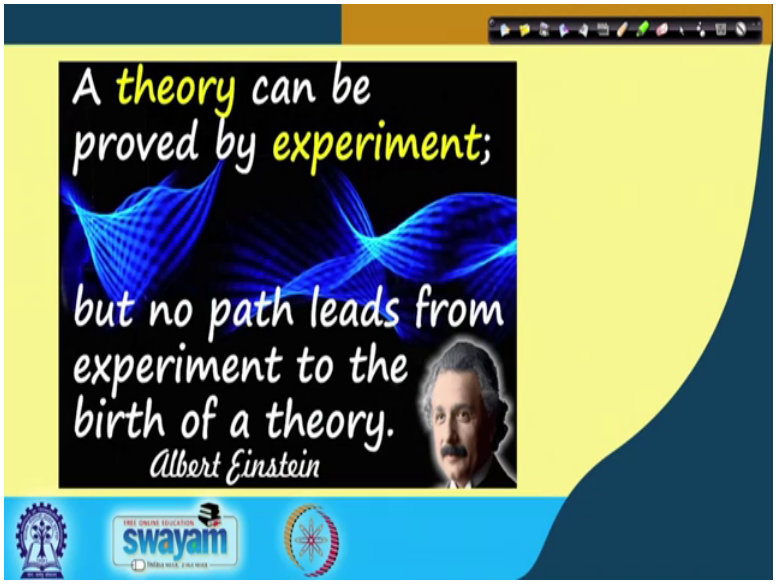

So, once again I would like to remind you, there is no excuse of experimentation. If you have to prove the theory; if you have to provide the best product service to the market, you must conduct the experimentation and experimentation must be designed scientifically and must be conducted smartly and effectively.

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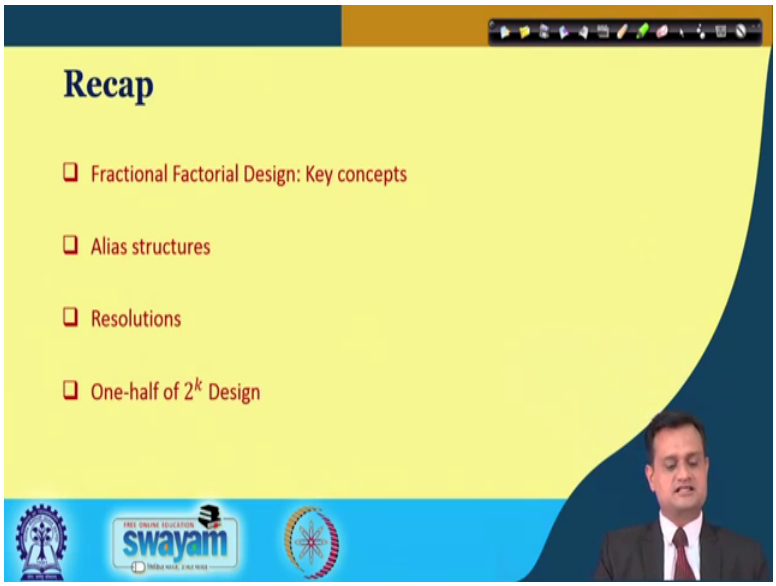

So, this is what we have seen in the last lecture fractional factorial design that helps me to get rid of the redundancy in full factorial design. I can figure out the resolution and alias structures, confounding effects and we had seen the one half 2 raise to k design.

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We will see the Minitab application.

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So, typically you need to follow the two steps in going ahead with the fractional factorial design in Minitab. Number 1 generate the design. So, that will help you to have your randomized experimental runs and then you analyze the design.

So, two steps if you follow, you can easily do the analysis of factorial in your Minitab.

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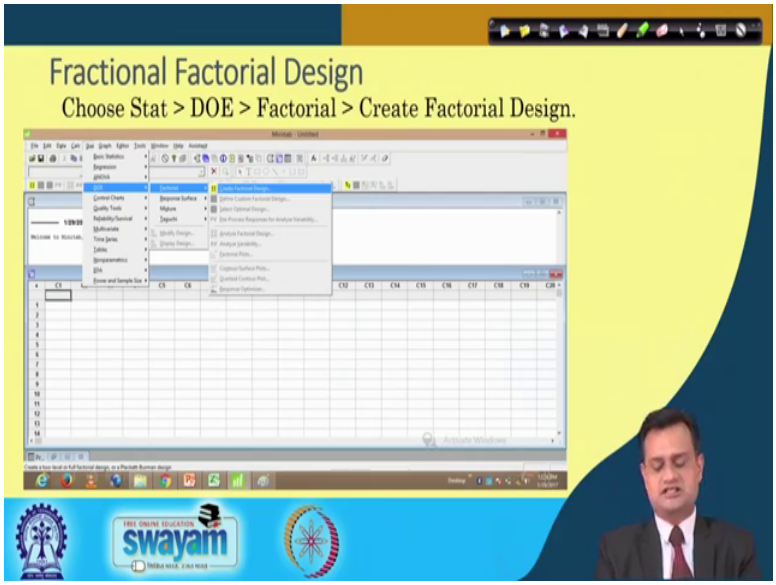

So, now just see what basically we are trying to do you go to stat again and you have DOE fraction factorial. Create Factorial Design. So, you go to DOE factorial, create factorial design and this way you will try to say perform the first step.

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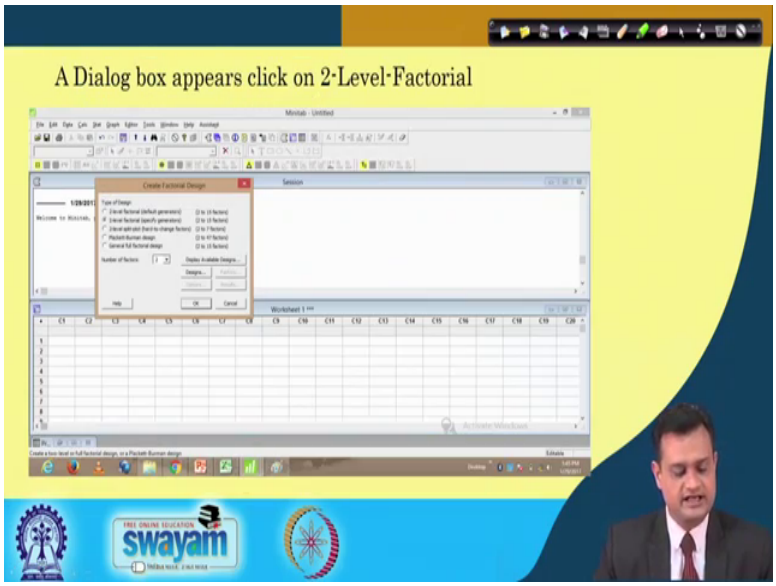

So, what do you do here? You have create factorial design window, you specify the level. So, you are referring to two level and number of factors let us say you have 2.

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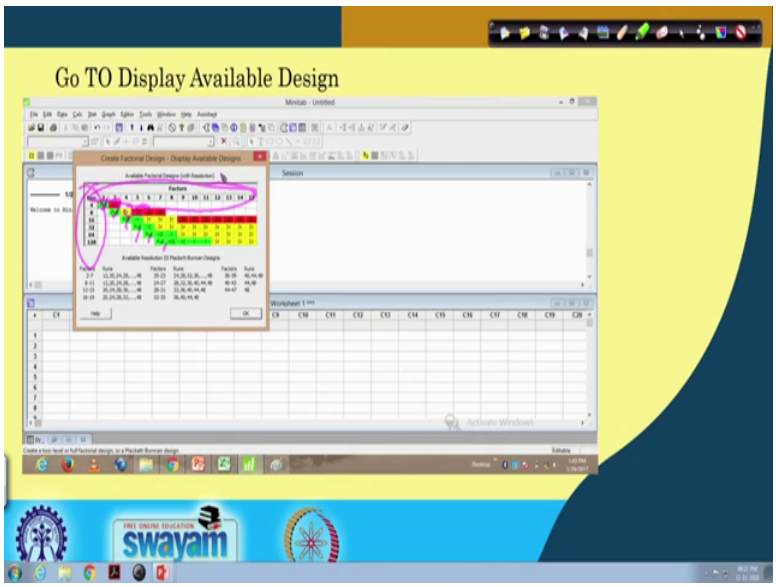

And then you will be exposed to a particular window. Now let us see what this window says. You have runs on this side and your factors on this side. So, now, you can see that this is all full. So, something which you see here fu double l, this is full factorial and you can see here the various resolutions.

So, your various resolutions resolution, 3 resolution, 4 resolution, 5; it goes to 6 7 8. So, you have the various resolutions as we have seen and this window will basically say that what are the available factorial design with the specific resolutions. So, once you are exposed to this window, then you I had tried to select again the two level factorial and number of factors are 4.

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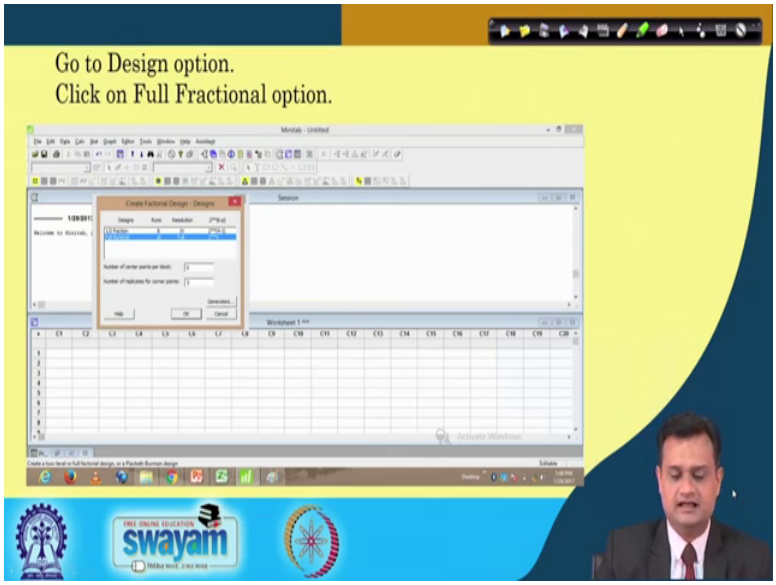

So, this is the window that you need to fill up, then you have half fraction and full factorial. So, let us say what you are doing; you are selecting the three replicates for corner points. So, for each corner point you will take the three reading and you are choosing the full factorial.

So, either you go for 2 raise to 4 minus 1 or you go for 2 raise to 4. So, you can have either fraction factorial or you can have full factorial. So, both the choices you can see here.

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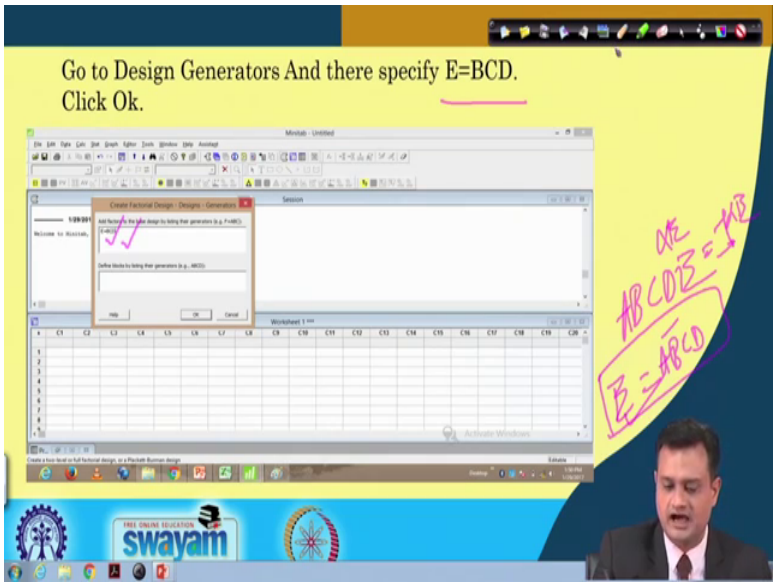

Now, you will what you will do there is little bit tricky, that in case of fraction factorial design, you define the relationship you define the generator. So, here you have a generator E is equal to BCD. So, you add the factors to this design by listing that generator. So, let us say E is equal to BC and D.

So, for example, you have ABCD and E this is five factor ABCD and E, you are just trying to define this E as a generator. So, the design which you have full factorial by giving the generator into your Minitab, you are actually conducting one factor less that is the half fractional factorial design. So, if I multiply suppose this is my I we have seen in the previous lecture. I multiply this by E both the sides into E into E, then I will get e is equal to a b c d and e square e square will be I that is one. So, E is equal to your ABCD. So, this is one way that you can define.

So, whatever defining relationship you have or generator you have, you can just put it here. So, it may be this or it may be this. So, it all depends upon how you have labeled the factors. So, now, I have the defining relationship.

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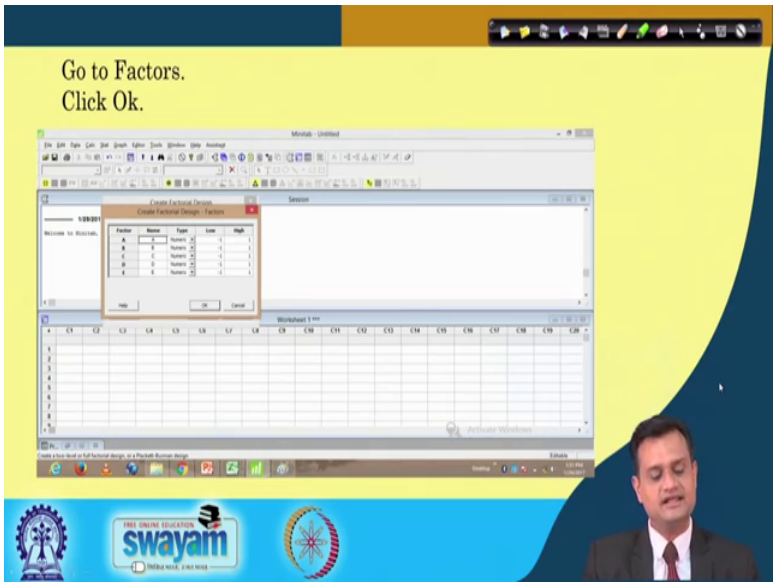

Now you have the window where you have to define the factors ABCDE and all are numerical let us say and you define the levels also. So, minus 1 stands for low plus 1 stands for high and once you have done this, you can just click to proceed further.

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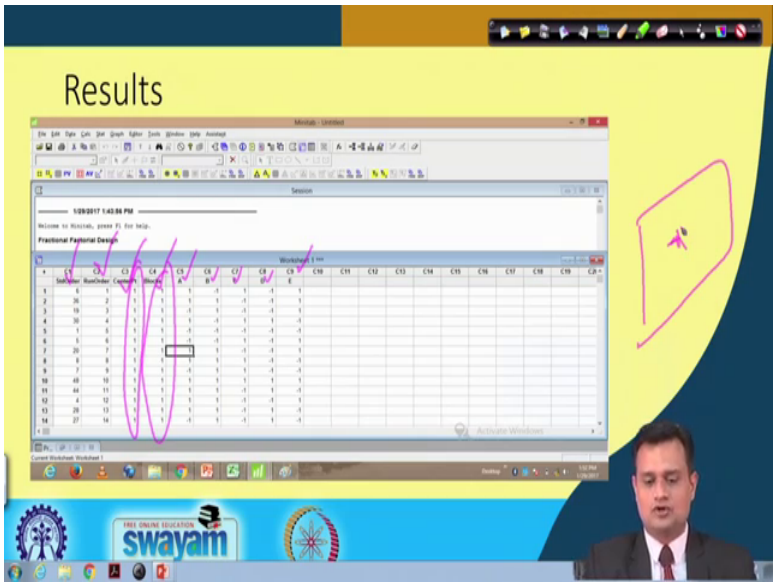

Now you have the fractional factorial design generated. So, I have selected the full factorial, but because I have defined the relationship. So, automatically this defining relationship will take care and I will have the less number of maybe if I am conducting half fractional factorial, then I will have only half number of experimental runs to be

performed. If you do not define and if you directly select the fractional factorial in Minitab then Minitab will automatically choose the defining relationship and create a fractional factorial design for you.

So, here you have created a fractional factorial design by defining the generator relationship and then what you see here is that C 1 is the standard order, this is the run order, this is the center point. These are the blocks, you will see one because I am not doing any blocking I am considering entire data set as only one block and then you will have ABCD and E.

So, you have basically A at 1, B at minus 1, C at 1, d at minus 1, E at 1 and likewise your design is basically created. You will have center point analysis also and this also helps me to analyze center point means in your design, there are corner points. I am also assuming some center point and this will help me to analyze by chance if there is any curvature present. So, this part we have not discussed in detail, but you can take care of it by center point.

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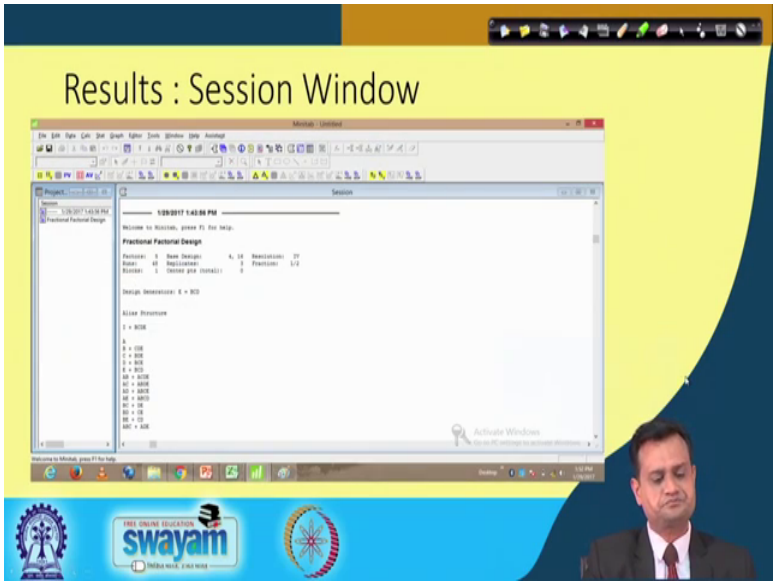

So, now you have fractional factorial design and interestingly your Minitab will give you the complete alias structures.

So, you will have main effect A B plus C D E C plus B D E. So, these defects are confounded and same way you have various confounding effects alias effects and you have the fractional factorial design for this.

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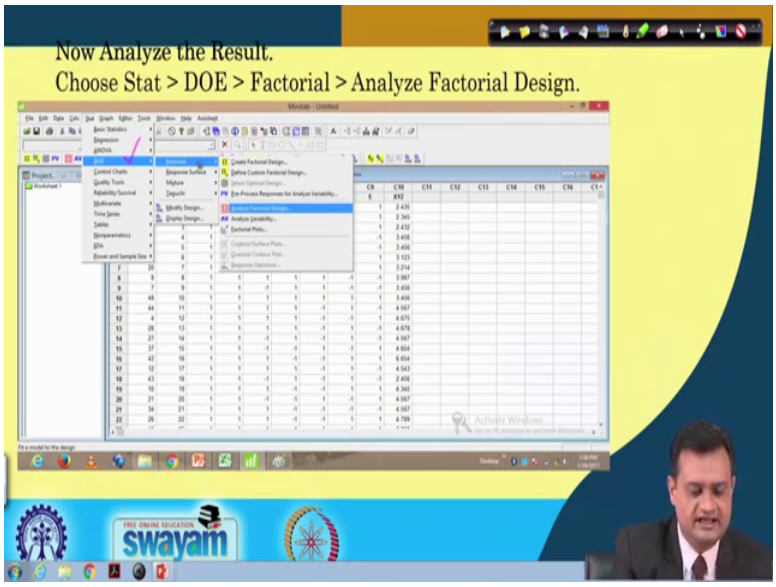

So, now, with this you have now the complete say created design in which you are putting this values that is your response. So, we have seen previously also that you try to put your response in the generated design. So, the design which is generated by the Minitab, now the second step is to analyze the design. Now in analyze the design, you once again go to DOE factorial, you go to analyze the factorial design.

So, even if it is fractional factorial I am going to factorial because I have defined the generator relationship that will take care of my fractional factorial.

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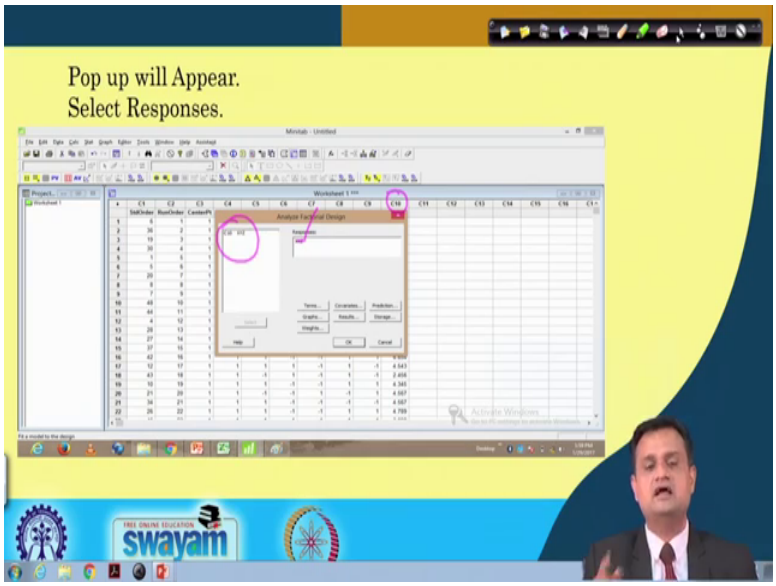

So, now you have response that is X Y Z and I will click ok. So, C 10 is basically response. This value you should feed manually for a given level of combination of the levels of various factors and then you click ok.

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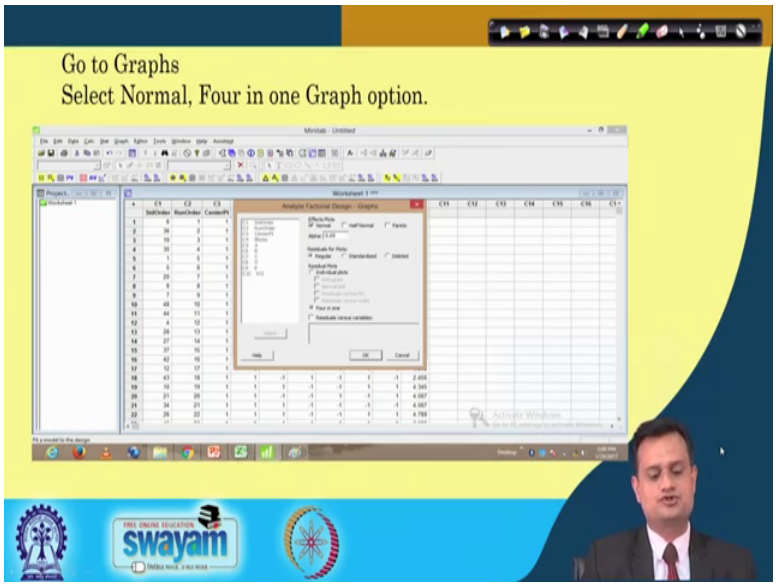

And then you try to select the graphs that you would like to check for checking the adequacy of your model adequacy of your analysis and I am selecting 4 in 1.

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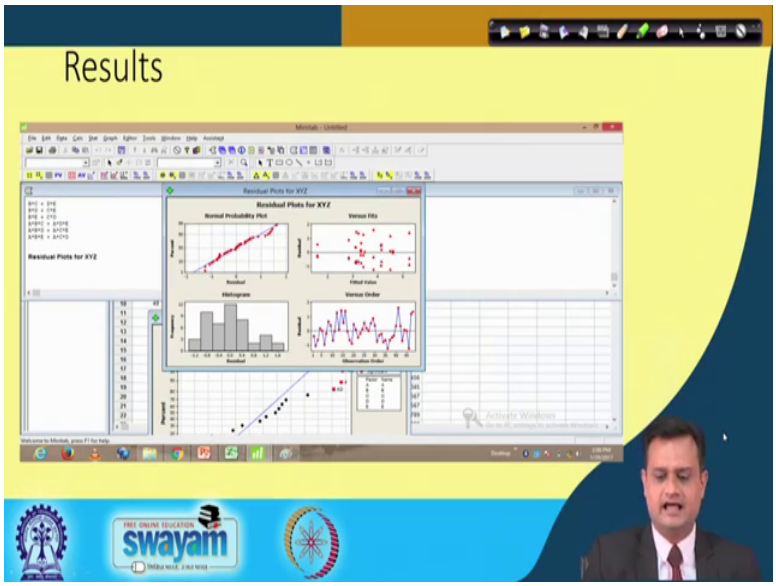

So, with this you click and what you will get is the residual plots for X Y Z response more or less it is normal. I can see that fitted value versus residual no particular pattern is observed more or less I get the feel or I get the idea of normality and there is no prevailing. So, my observations are independent and the assumption of independence is also checked.

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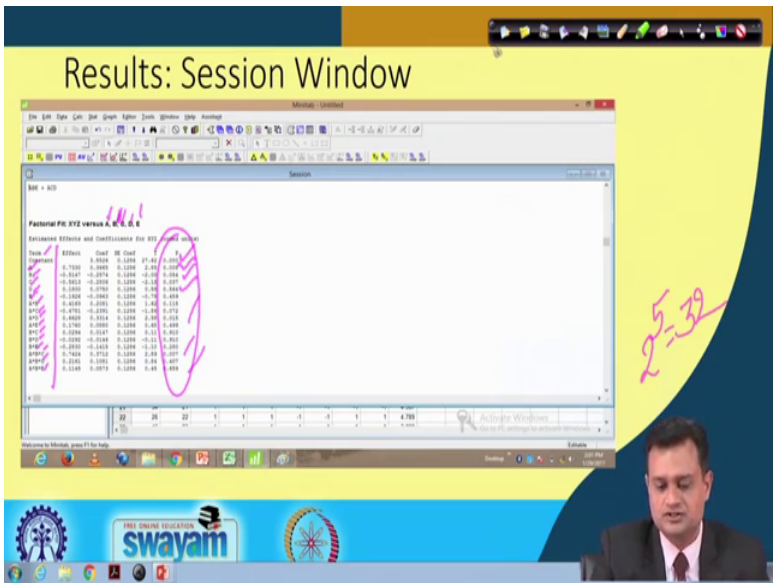

So, now once this is done, you can also have the estimation of the various effects. So, these are the effects, you have estimated and basically you have 1 2 3 4 5.

So, total you have 5. So, if I am conducting full factorial, I do not define the relationship, then 2 raise to 5 is equal to 32. So, full factorial will basically estimate the 32 effects. In case of fractional factorial, you just see that you have 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16. So, basically you have total 16 effects analyzed and this is my half fractional factorial.

So, you can see the P value for each and you can comment that a particular effect if it falls in the rejection region the observed value P value. If it falls in the assumed level up significance region, then null hypothesis is rejected. It means this effect is not significant; you will say that this effect is significant. So, if we just quickly see that A is not say false in the rejection region.

So, I will say it is significant, this again false this again false same way. If you see this falls in the acceptance regions with 0.564 even if I have 0.5 level of significance, this is much higher value falls in the acceptance region. I will accept the null hypothesis which says that this effect has no impact on my response and same way you can analyze all.

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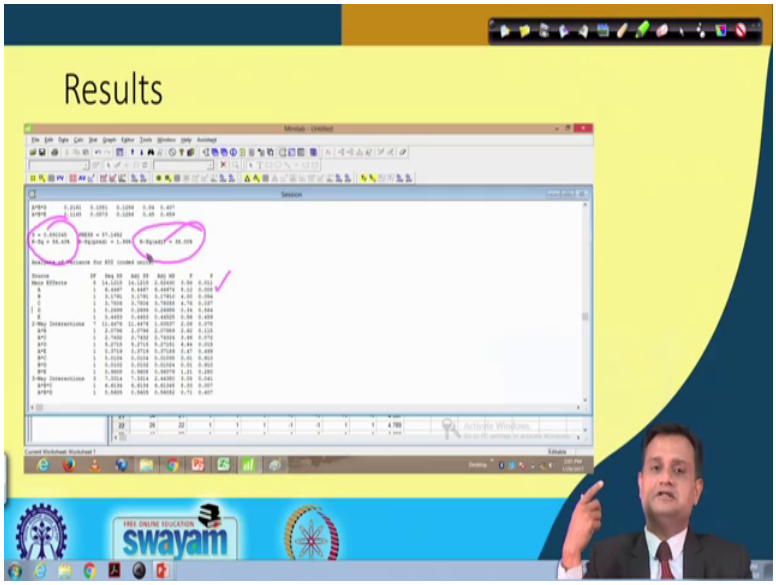

So, this is what exactly you can do and you have the main effect two way interaction, three way interaction separated and you can very well check that whether they are significant or not.

So, this is what you can do. You can also interestingly see that point 0.8 point is falling in the rejection region. Suppose I have 0.025 so, this is the smaller value which will fall in the rejection region and this effect I will say is I reject the null hypothesis and it is significant for a given level of significance. Here you can also see that you have the r square 56.43 and adjusted r square 36.00. So, this is not much satisfactory.

So, usually you should expect the value more than 75 percent or 80 percent. So, this says that their total variability is not basically captured by the factors I have assumed and there could be possibility that other factors that has an effect on the total variability of the data set. So, these are the interpretations of my output.

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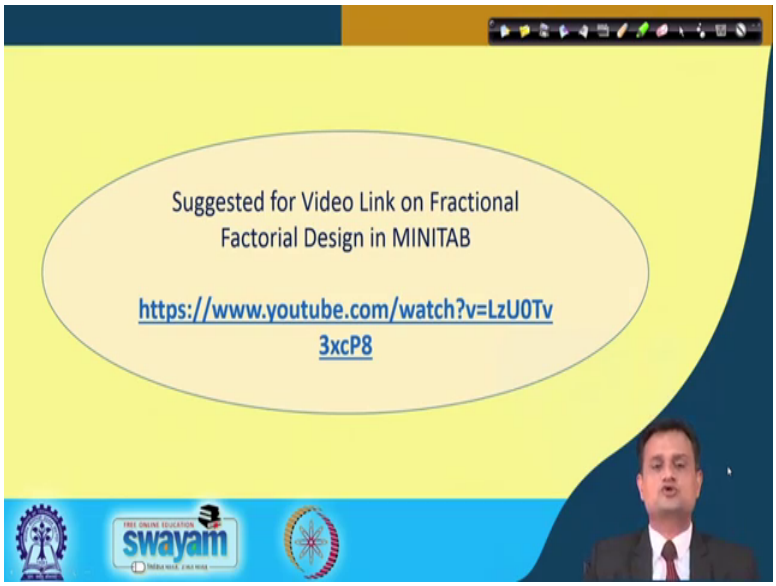

And you can also refer this particular link to gain greater insights into the Minitab application for fractional factorial.

So, I suggested that basically you are conducting full factorial with a defining relationship. If you choose the option of fractional factorial, your Minitab will automatically take the defining relationship and conduct the experimentation for fractional factorial.

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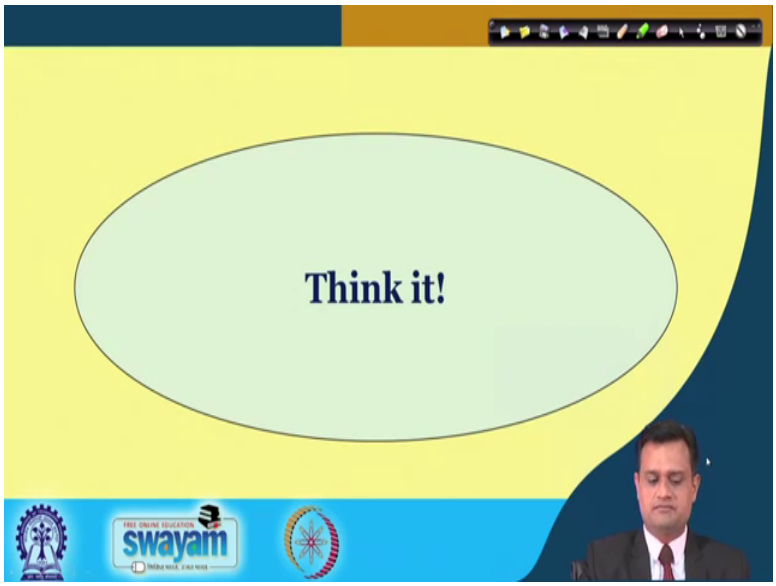

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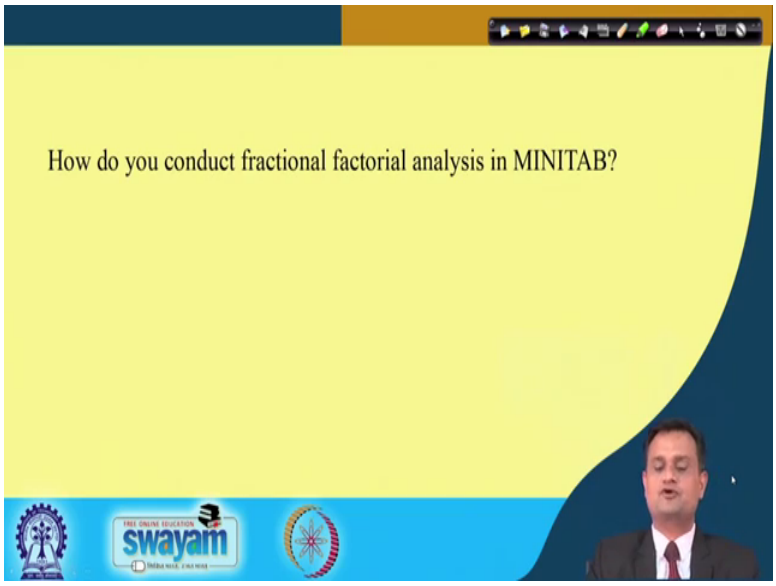

So, this is about Minitab application; how do you conduct fractional factorial analysis Minitab. A simple think it question. List down the steps, take some data set a small data set hypothetical data set, conduct the analysis and try to have better confidence in the use of Minitab for analyzing fractional factorial design.

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So, you can use this particular reference.

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And fractional factorial are the most widely used say design for products and process design, process improvement and the various experimentation. So, thank you very much for your interest in learning the Minitab application for fractional factorial and I hope you would feel confident in conducting such analysis with Minitab. Be with me, we will discuss more topics in our DMAIC cycle enjoy.