Design and Analysis of Experiments
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Lecture – 57
ANOVA using MINITAB

Welcome to the lecture number 57; design analysis of experiments. I am a TA of this course, my name is Souvik Das. In this lecture, I will perform that how to do ANOVA using MINITAB.

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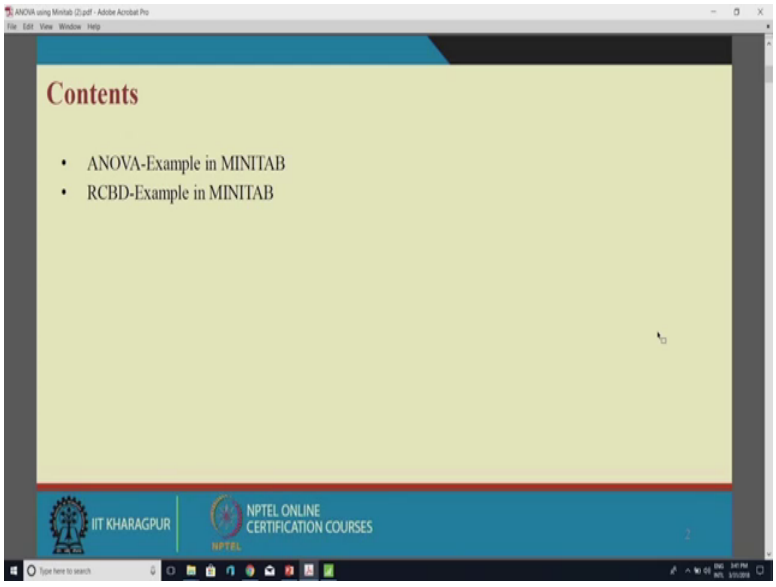

So, this is the topic of this lecture. So, the content will be ANOVA, example in MINITAB, then I will do some randomized complete block design that I will that will also be performed in MINITAB.

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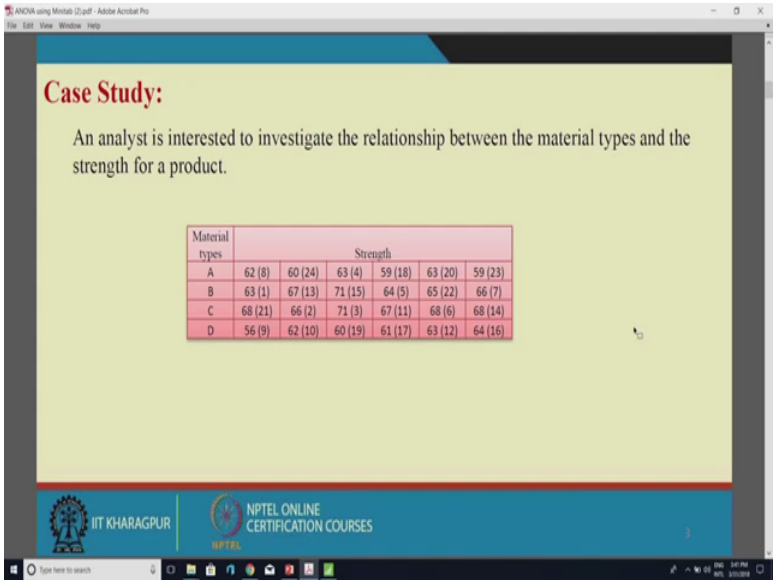

So, directly, I am going to the case study, in this case study, it is saying that an analyst is interested to investigate the relationship between the material types and the strength for a product.

This is a randomly performed experiment that we can see that in material type B for strength is 60 and the and strength is a first strength the randomize is a random one; this is 63, then it is random 2 means we are performing the run in a random order. So, we will take this example and we will do in ANOVA; we will do ANOVA analysis using MINITAB that how to do it in MINITAB.

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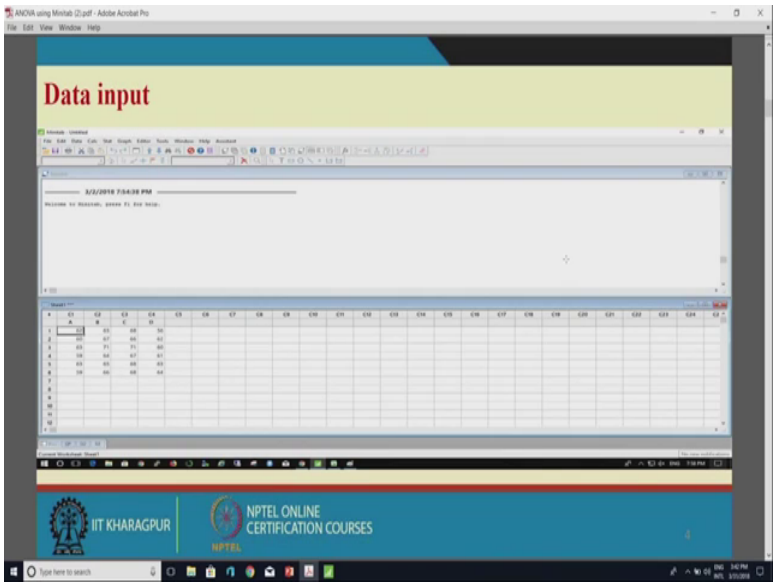

So, this is the data input that how we will import the data in MINITAB. So, I am going to the MINITAB software, first I am writing all the here, this is the material type; this is material type.

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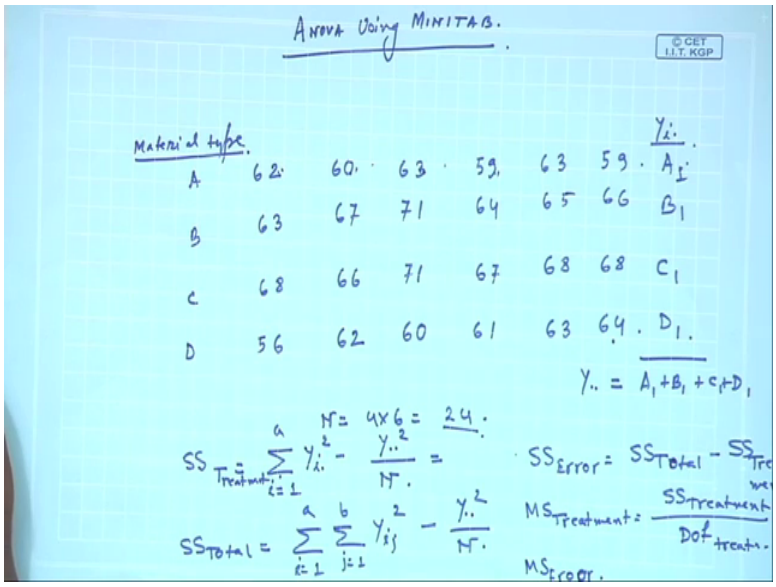

So, this is A, B, C, D.

Then it is 62, 60, 60, 63, 59, 63, 59, then it is 63, 67, 71, 64, 65, 66, 68, 66, 71, 67, 68, 68, this is 56, then 62, 60, 61, 63, 64. Now our fast track's is we have to get this data in excel.

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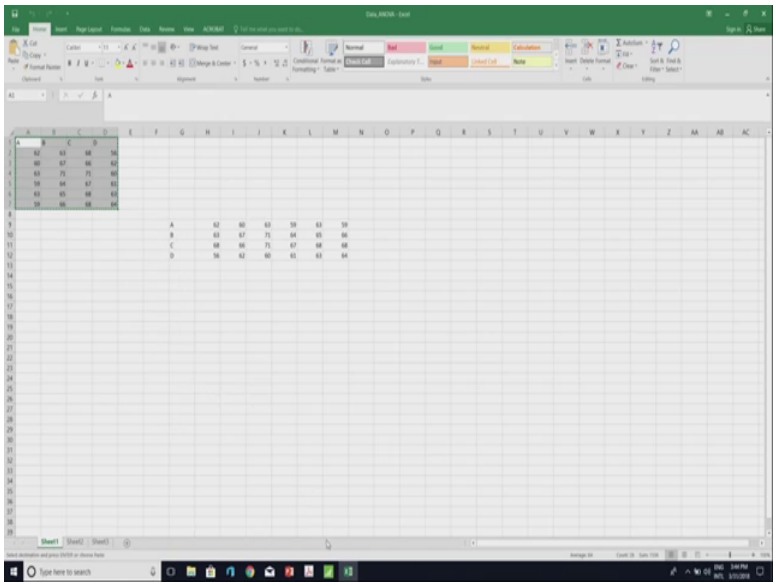

So, see this section; that how we have entered the data in excel as this is material type. So, we have put all the values in column like 62 it is in the under A, then 60, 63 in that way, we have organized the data. Now, we will just copy it copy and we will open our MINITAB software and just, we will paste see the data is it the data is coming in the MINITAB. Now, we will go to the stat after the stat we will go to the ANOVA and then from ANOVA, it is one way ANOVA. So, now, they are asking that response data are in one column for all factor level, but our factors are ABCD.

And data are in different column. So, we will put the response data are in separate column for each factor level when you will go for response it is coming that response are 4 response for factor level A, factor level B, factor level C, factor level d.

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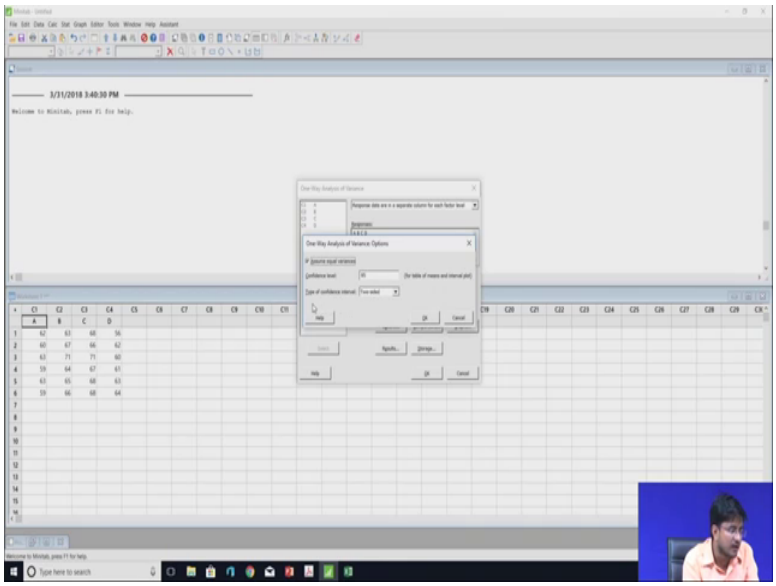

So, we will select all the first A, then B, then C, then D, after the after selecting all the responses, we will go to the option section in options action, it is saying that confidence level is 95, you can change it according to your problem statement.

Now, it is saying also the type of confident interval, it is two sided or one sided, A the lower bound is given or upper bound. So, we will put it two sided it, then we will go ok.

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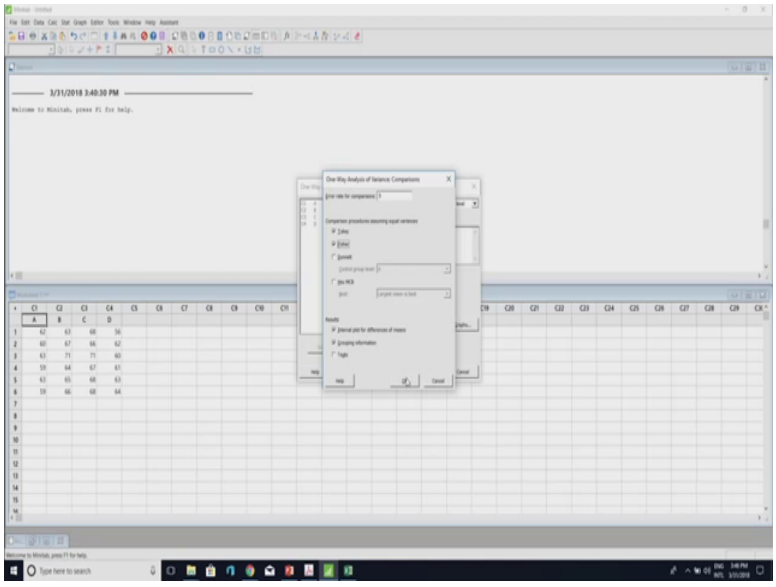

Then this is comparison when in the lecture we have seen that there are 2 comparison Tukey's case and Fisher LSD test.

It is basically compare the means of the treatment. So, we will tick this Tukey and Fisher, then we will go.

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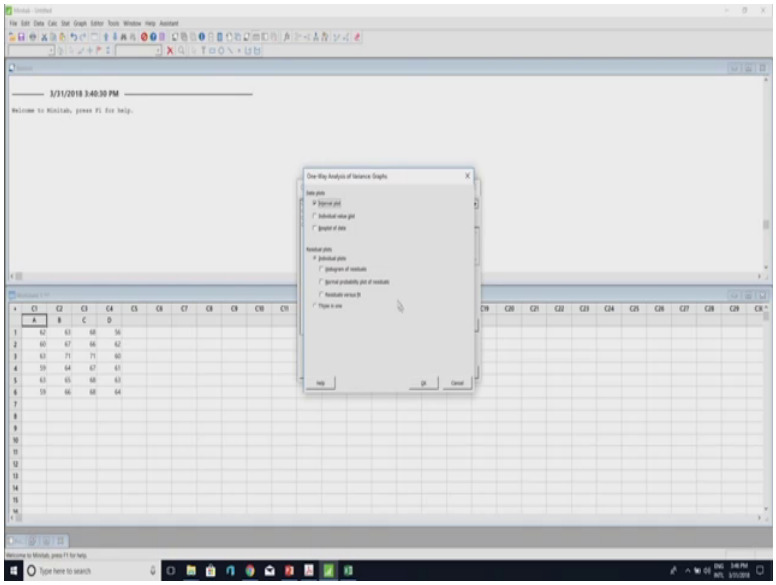

Then graph what types of graph we need here interval plot individual value plot box plot of the data. So, then for residual plot it is individual plot histogram of residual normal probability plot of residual, residual versus feet all the things, we can tick you will get all the graph.

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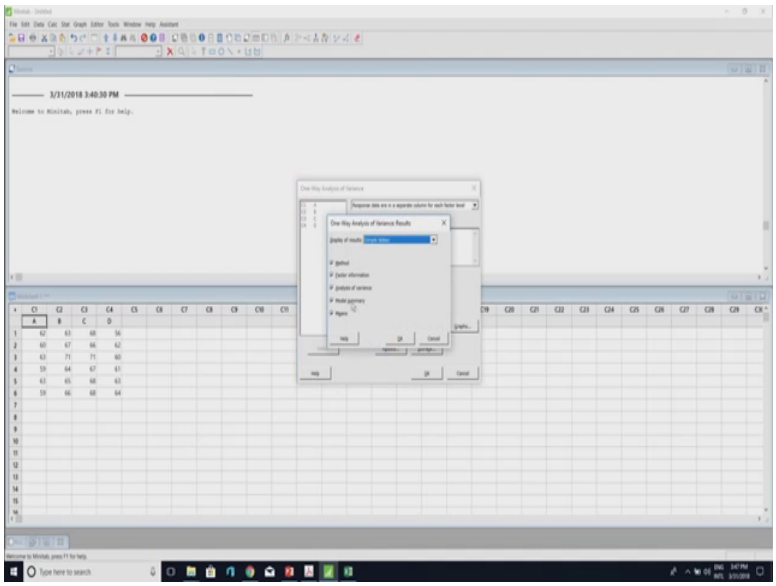

Then this is the result that what types of result do you want to get this in sample table, we will get all the result, we will get that what method you are using what is the factor information, then the ANOVA table what the model summary and then means.

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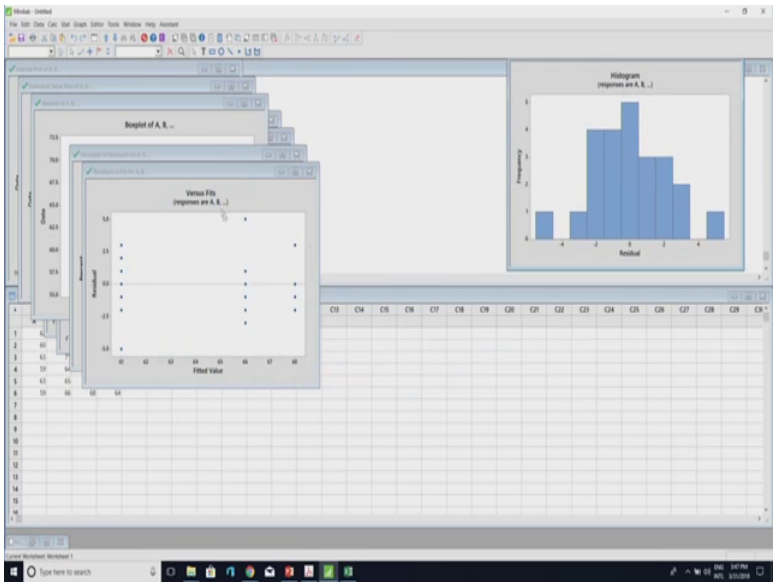

So, I am going last to. So, this is all the graph we have got; the this is histogram this is residual versus fitted value.

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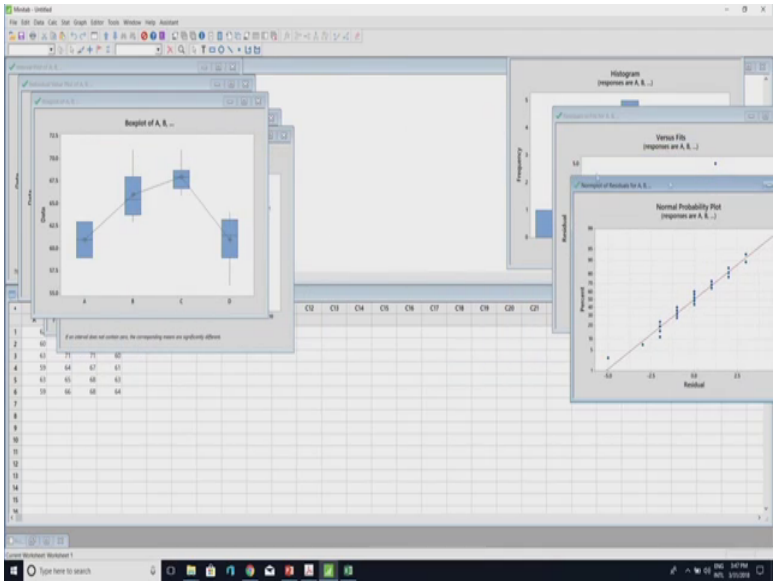

This is normal probability plot; this is box plot of all the factors.

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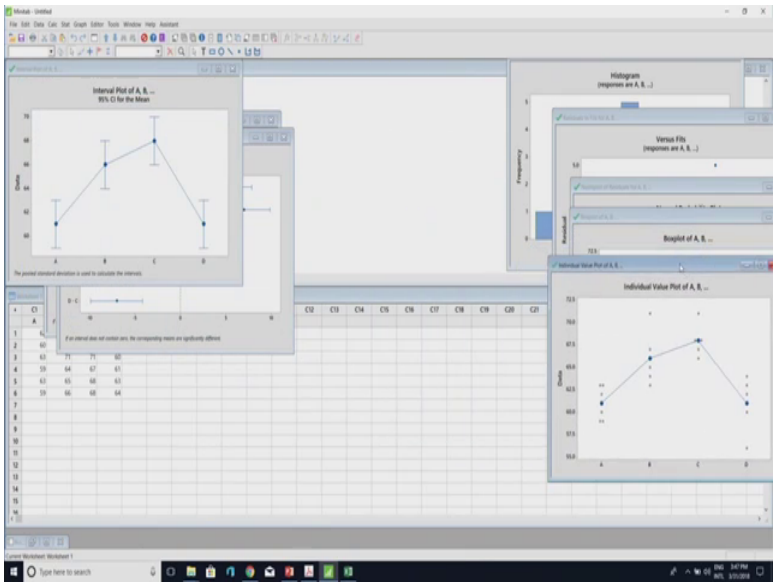

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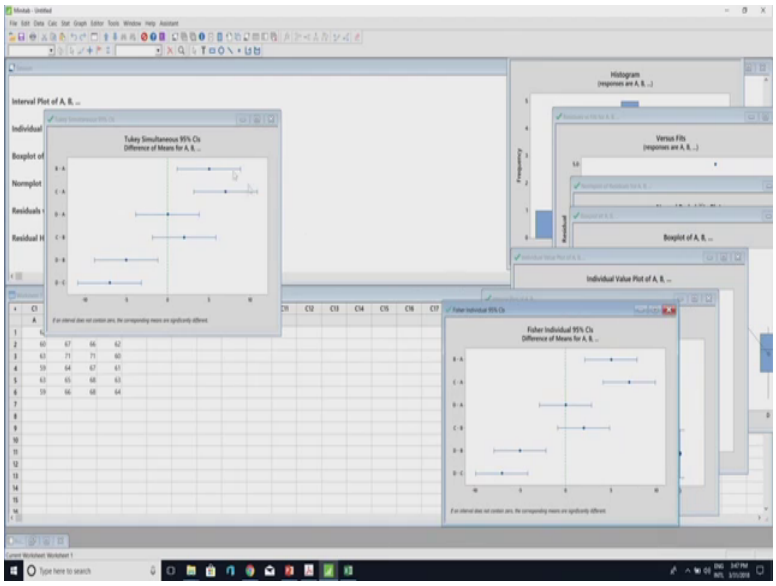

This is individual value plot, then interval plot, then fisher LSD fisher LSD plot that Tukey's and also we will get the result here. So, in the here, we can see if I extend it. So, we can see that this is our my ANOVA table that there are factors in sources this is factor that is treatment.

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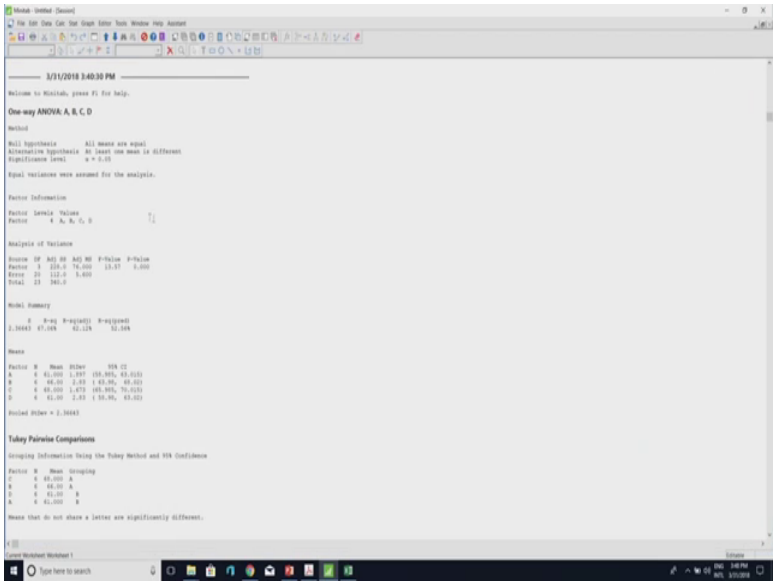

In lecture, we have learned it as a treatment in MINITAB it is coming as factor. So, the degree of freedom is 3 as there are 4 factors. So, then that will be 4 minus one that 3 then what is the SS square is 228.

Then what is the MS square this is 228 Y degree of freedom that is 76 then error term also, we will get SS error during the degree of freedom is 20, the total is 24 data we have. So, 21 minus 1; this is degree of freedom of total 23 and 23 minus factor degree of freedom 3 that is then they will get the error degree of freedom that is 20.

So, in error the SS is 112 at this SS is 5.6. Now, accordingly also here, we get new model; summary will get that what is the standard deviation, then what is the R square value adjusted R squared value all the things, then what is the mean of the factor A; what is the standard deviation of the factor A; what is the 95 percent confident interval of the factor A? All the things, we have got.

Now, this is the Tukey's comparison test and the fisher LSD information also we have got in this section. So, this is how to perform MINITAB. So, in manually what we do in when we analyse ANOVA; what we do? First we add all the value suppose in this section this is Y i dot what we do we had 62 plus 60 plus 63 plus 59 plus 63 plus 59, suppose, we have got a sorry, this will be A 1 to differentiate from this type, then for B again, we will add A this.

So, we will get B 1 for C, we again we will add this, we get C 1 for D, it will be D 1, then we will add all the 3 all the 4 A 1 plus B 1 plus D 1.

So, this will be Y dot dot and the total value that is n here is this is 4 and this is 1, 2, 3, 4, 5, 6 to 4 into 6; that is 24. So, our in our ANOVA; what is the SS treatment that is nothing, but summation of i is equal to 1 to a number of treatment, A is the number of treatment, Y i dot square minus Y dot dot square by n all the Y i dot we will get Y dot dot; we will get from here n; we will know 24. So, in this manner, we will get SS total, sorry, SS treatment; this is SS treatments, then for SS total who will do that all the value square that 62 square plus 60 square plus 63 square plus 59 in this manner up to 64 squares.

So, it will be double summation I is equal to 1 to a j is equal to 1 2 B Y i j square minus Y dot dot square by n, then SS error will be SS total minus SS treatment, then we will get the MS error MS sorry MS treatment first is equal to SS treatment by treatment degree of freedom degree of freedom of treatment, then same manner MS error we will calculate.

So, in MINITAB; what we are getting that this is the SS t treatment sorry MS treatment that is 26 and MS error this is 5.6.

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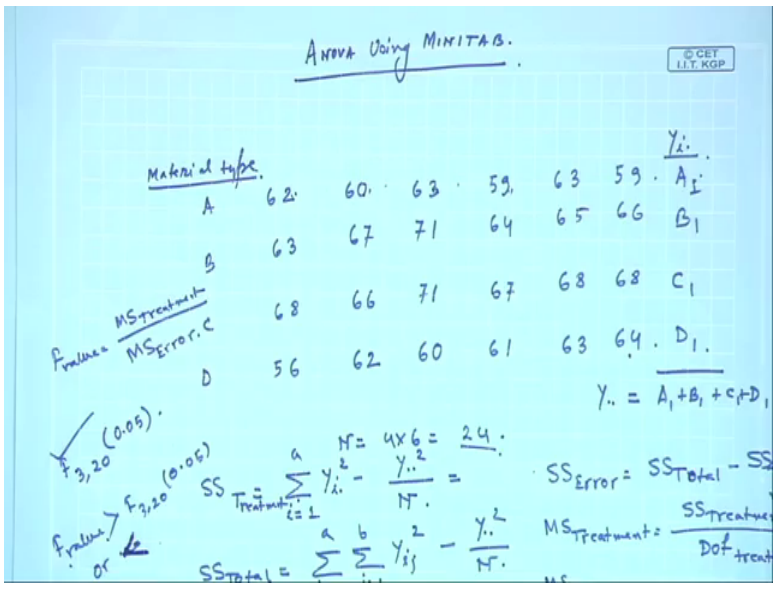

Now, the F value; we will calculate F value is equal to MS treatment by MS error. So, the F value we will get. Now, we have to compare with the tabulated F value here tabulated,

F value is MS treatment is the degree of freedom MS treatment is this is will be 3 and MS error will be this will be 20 and in this case our alpha is 0.05.

So, from table, we will get this value. Now have to compare that F value is greater than from this tabulated value or less than from this tabulated value. So, if this value will be greater than the tabulated value, then we can say that the material type is significantly affecting the yield rate or if this is the less, then we can say that material type does not significantly affecting the mean rate.

So, this is the mini ANOVA analysis in MINITAB. Now, I am going to and how to analyse Randomized Complete Block Design in MINITAB.

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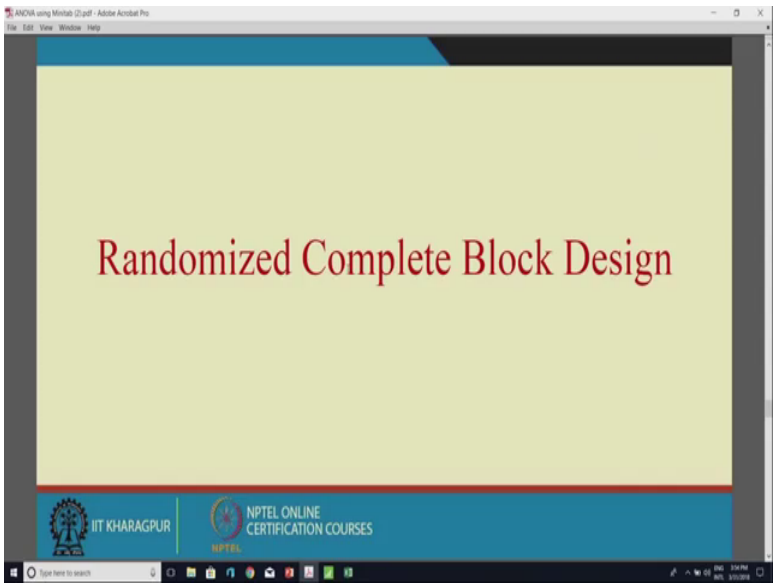

This is the randomized complete block design though last I have say it that why it is randomized that we are performing all the experiment in random order that is it is called randomized.

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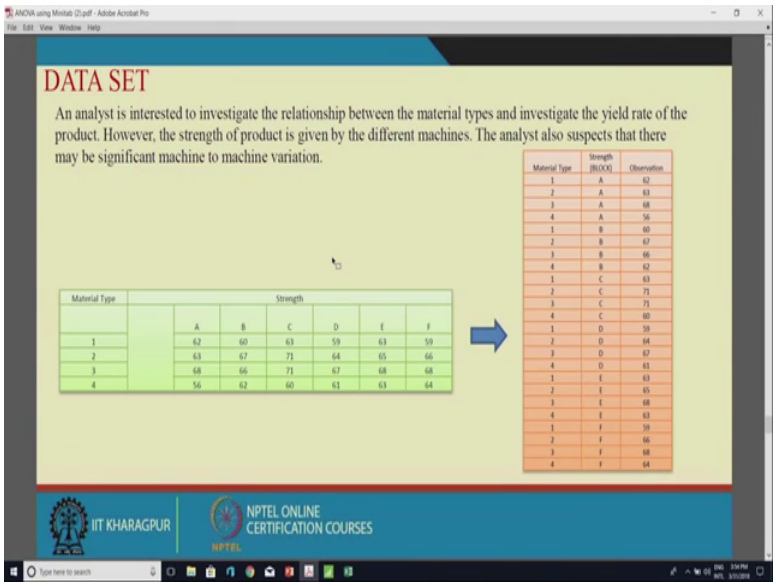

And why it is complete block design because if we take, if we see this example this is material type and strength and these are the yield rate. So, if we take the strength analysis the strength is given by different machine. So, due to this machine variation yield rate can be different. So, we have we have taken the strength is as a block.

So, when we take it as A block, we see that all the material type if this is A is the block B is the block, then from this, we can see that in a all the material types are present in B all the material types of present that is it is in that that is why it is called complete that all the complete material types are present in one blocks.

So, in ANOVA when we going we are going to analyse block design randomized complete block design we have to design our data like this first we have we have we have this type of data this is material type this is strength A B C D E F. So, please these are the yield rate 62, 60, 63, the same data we are using here now we have to design in such a manner that material type one 2 3 4 then for strength A all the observation are there.

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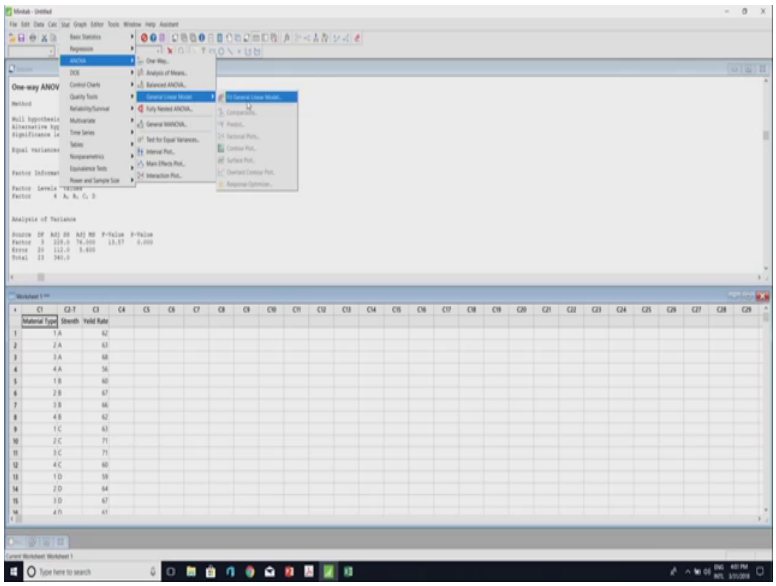

Then for strength be all the observation for there. So, this type of structure of data we have to make in excel we have to put all the data. So, I am writing; this is material type. Then it will be strength, then it will be a yield rate. So, material type 1, 2, 3, 4 and for strength, this will be a a a a this is our data for material type 1, 2, 3, 4 and for strength aaaa. So, this is 62, 63, 68, 56 yield rate is 62, then 63, then 68, then 56.

Then again material type 1, 2, 3, 4, strength will B, B, B, B, B, real rate will be 60, 67, 66, 62, then it will be 5, again, material type 1, 2 3 4 it will be C C, C, C, database, 63, 71, 71, 60, again, it will become 1, 2, 3, 4, dt dd; this 59, 64, 67, 61, 1, 2, 3, 4, this will be E, E, E, E this is 63, 65, 68, 63.

Last one is 1, 2, 3, 4, material type and strength is F, this is F, this is F, this is F and yield rate is 59, 66, 68 and 64. Now; my data set is ready. So, now, I can copy from here and directly put to the MINITAB. Now, my data set is ready in MINITAB, this is the data set of complete randomized complete block design. Now, I will go to the stat, then I will go to the doe, sorry, I will go to the ANOVA then from ANOVA, it is generalized linear model then from general linear model to fit general linear model.

Now, it is saying that what are the response here response is yield rate to select, what are the factor factors are material type and also strength we are taking strength as a block. So, now, random and nest this material type, this is fixed model, then in model interaction to only material type and strength their interaction, we are not considering as

it is the strength we are taking it is as a block when an option, there is 95 percent and 2 sided, then in graph, we will go to the graph and all the graph, we will one in a single phase. So, 4 in 1, this is the option and result, the saw all the result, we know we want to get.

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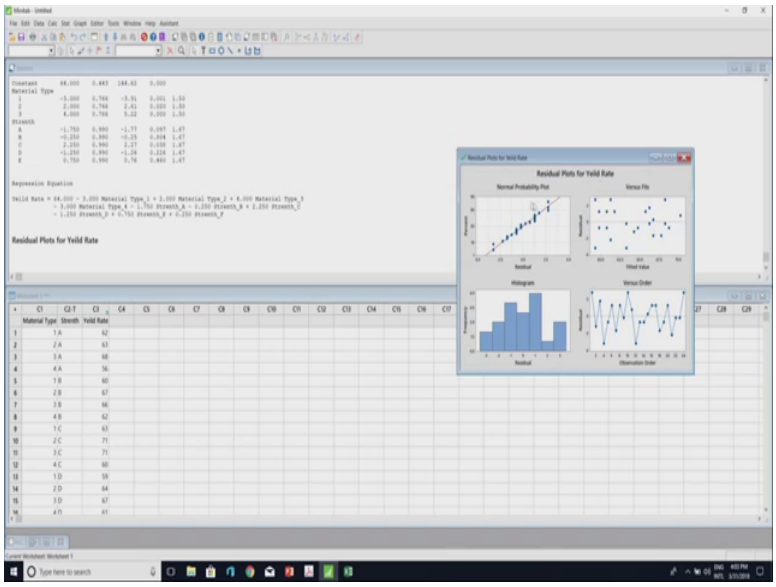

So, all the tick we have done. Now, you will go to the. So, this is the graph; we have got that this is normal probability plot, this is residual versus fitted value, this is frequency of the residuals, this is observation order versus residual. So, now, in that case, we have got that this mess material type and the SS square is 228 and the strength we have taken as a block, it is 41.50 and error, it is 70.50.

So, again the same thing; we all will do that we will calculate the MS using the adjuster SS square and degree of freedom, then again we will calculate that a value, whether the treatment mean that in material type with the treatment, here whether that treatment means are affecting the yield rate or also, the block the block, we have taken that is affecting the yield rate that you will be get from F value.

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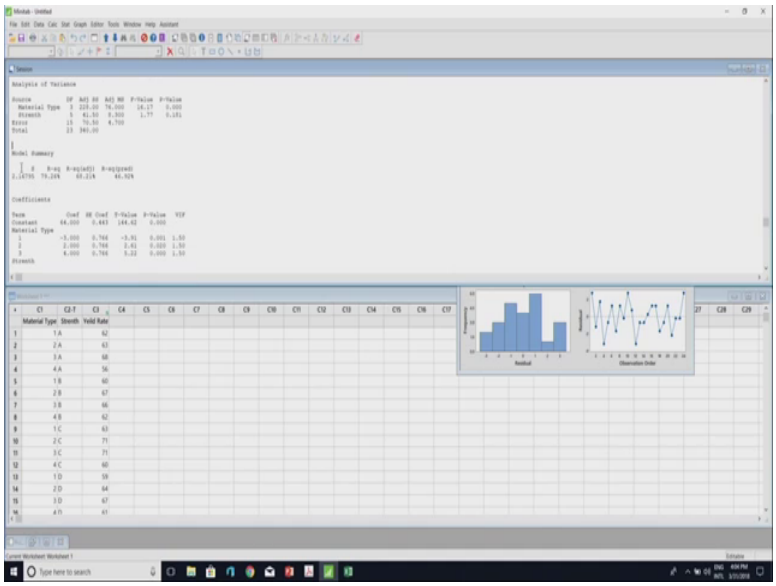

And again all the details of the model and what is the standard deviation r square value adjusted r square value, we will get and the total things, we will get. So, this is a randomized complete block design.

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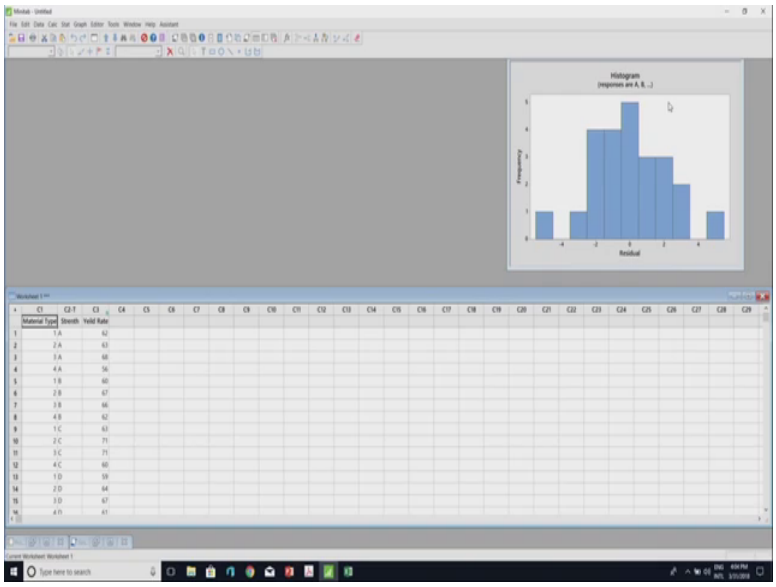

So, in manually; what we do? Suppose, this is our material type this is our material type.

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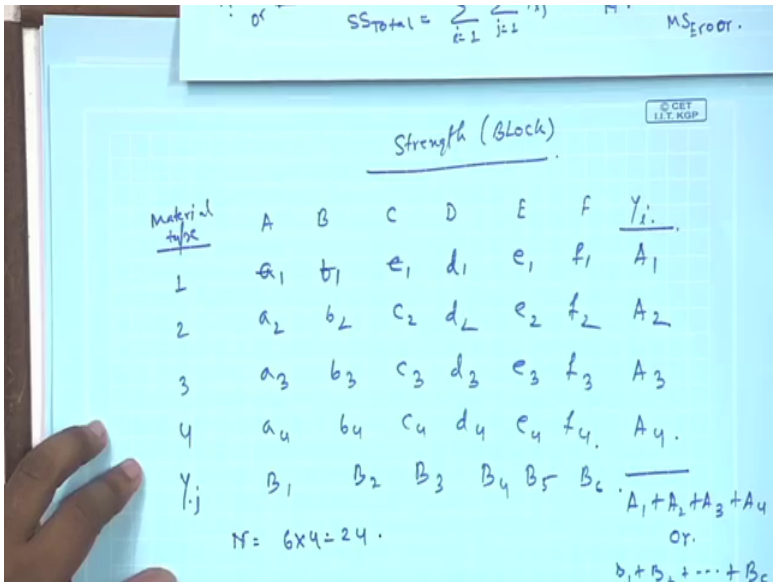

In this example, all the things are 1, 2, 3, 4 and this is the strength that we have taken has blocked A B C D E F.

And all the value are their values are they are suppose it is a one B one C one d 1, e 1, f 1, a 2, b 2, c 2, d 2, e 2, f 2, a 3, b 3, c 3, d 3, e 3, f 3, then it is a 4, b 4, c 4, d 4, e 4, f 4. So, again the same way, we will calculate all the sum of these this is Y i dot that a 1 plus b 1 plus c 1 plus d 1, then we will get big a 1, if you calculate sum all the a 2 plus b 2, then this is a 2, similarly a 3 and a 4 and if we sum this is Y dot j, if we sum all the A 1 plus A 2 plus A 3 plus 4, we will get B 1, this is B 2, B 3, B 4, B 5, B 6.

Then we will calculate the total sum that is either A 1 plus A 2 plus A 3 plus A 4 or it will B 1 plus B 2 plus dot dot dot plus B 6 and here also n is the total number of that is 4 here.

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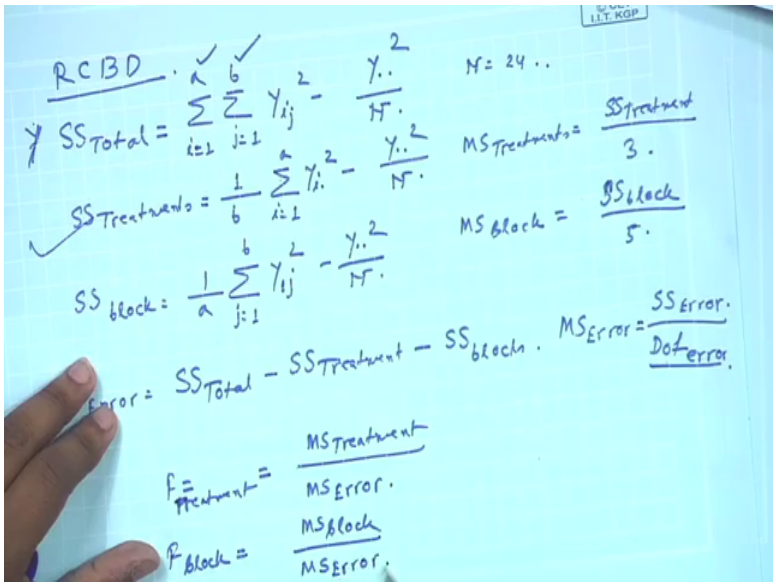

And this is 6. So, 6 into 4 that it 24; now using this data set in randomized in RCBD randomized complete block design will flash first calculate SS total, SS total is sum of all the things that is A 1 square plus B 1 square plus C 1 square plus all the sum that is summation of I is equal to 1 to A and j is equal to 1 to B.

A is the number of treatment and B is the number of block Y ij square minus Y dot dot square here Y dot dot is this either A 1 plus Y dot dot is A 1 plus A 2 plus A 3 plus A 4 or B 1 plus B 2 plus B 3 B 6. Now Y dot dot square by n here n is 24. So, in this manner, we will get the SS total, then SS treatment, it will be 1 by B summation of i is equal to 1 to a Y i dot square minus Y dot dot square by n.

And SS block will be 1 by A summation of A is equal to 1 to B Y dot j square minus Y dot dot square by n. Now SS error can be calculated using SS total minus SS treatment minus SS blocked and we know the degree of freedom of SS treatment is there are 4 treatment in this data there are 4 treatment. So, degree of freedom will be 4 minus 1 that will be 3 and there are 6 block A, B, C, D, E, F.

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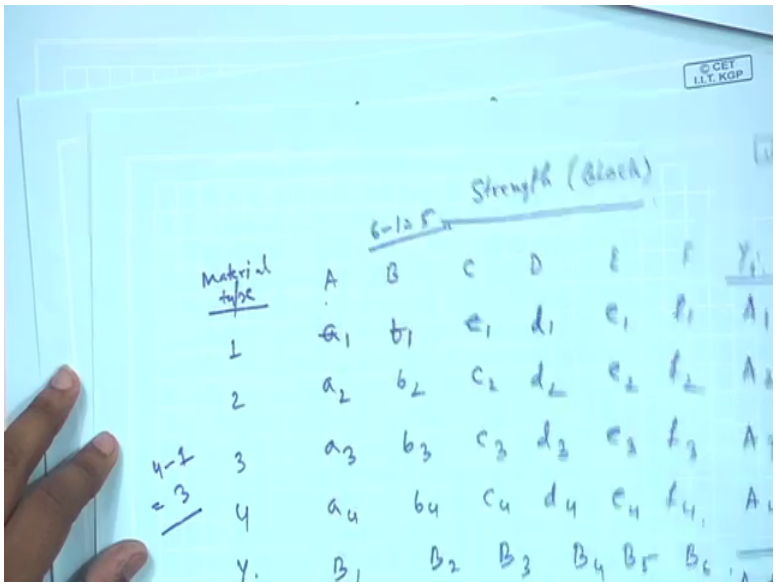

So, the degree of freedom will be 6 minus 1; that is 5. So, we can calculate that MS treatment will be SS treatment by degree of freedom of treatments that is 3.

And MS block that will be SS block by degree of the block that is 5 and also MS error, we can calculate in similar manner that is SS error by degree of freedom of error. So, now, we can calculate the F value of treatment F value of treatment, it will be MS treatment by MS error F value of block will be MS block by MS error.

And from that analysis we can see that; what are the effects of treatment and block; So, all the things, we will get from the lecture that side has taught in the previous lecture that ANOVA randomized complete block design, you will get all the things and all the concept that why you we are using ANOVA; why you are using we are going for randomized complete block design.

So, please go through all the lecture that is side has thought and this lecture is basically how to use MINITAB for analysing ANOVA and randomized complete block design.

Thank you.