Advanced Green Manufacturing Systems
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Lecture - 21
MS Excel Solver demonstration

Good afternoon students, welcome back to yet another lecture of Advanced Green Manufacturing Systems. And we have been looking into how to formulate optimization problems and how to use Excel to solve that problem and I have shown you in a power point how the entire problem is being set up and now what we are going to do is, we are going to use Excel Microsoft Excel to do a live demonstration of the same.

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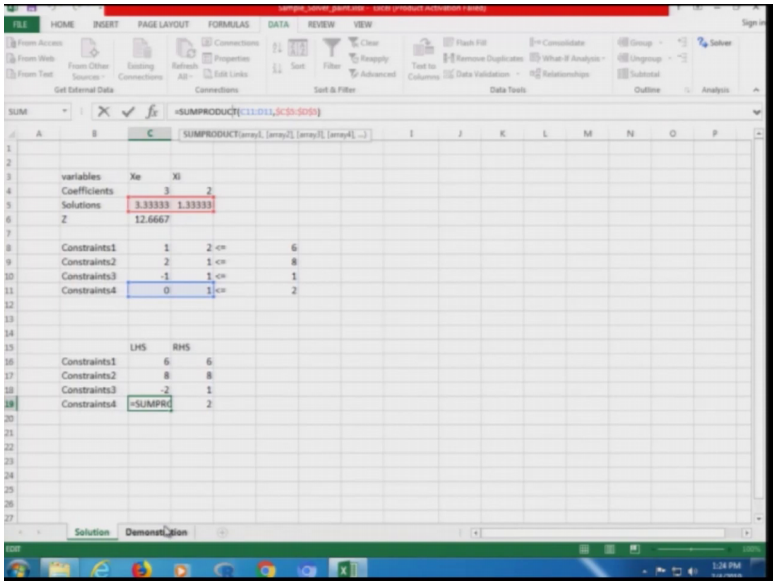

So, if you look into this and to the screen I have Microsoft Excel kept here, which has a complete setup of the problem as we were talking the variables a both X e X i the coefficients and the final solution of the and their Excel ok.

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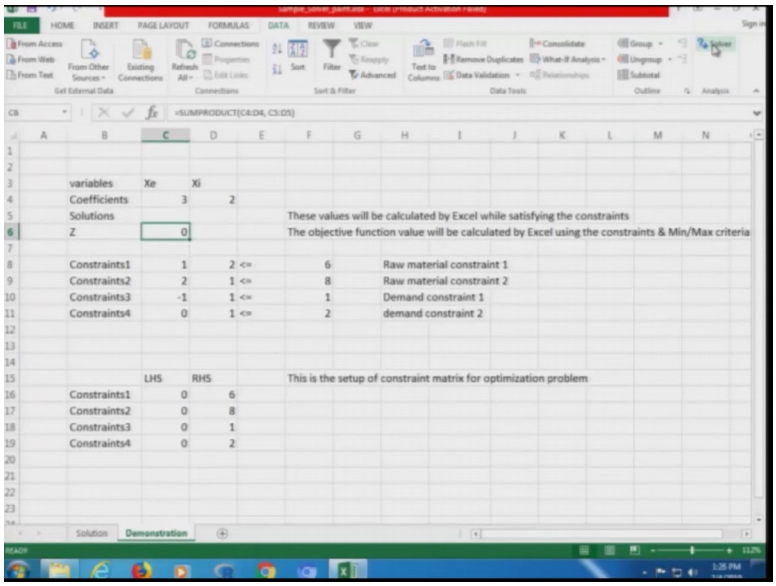

And I have a Excel demonstration page in which only the basic setup is there, the remaining solutions and RHS is setup is not there. We will use this as a reference guide and we will set up this page accordingly by referring to this. So, that you can understand that and then you can use my presentation as a reference guide to study it all by yourself.

So, first and foremost assume that you are basically setting up this is the final solution this is the basic page. So, you have two variables X e and X i, both the variables are there X e and X i. So, first we setup this matrix variables matrix both the variables are declared X e and X i and the coefficients of the variables are 3 and 2 respectively which we have kept here. The solutions as of now these are the values that Excel will change ok.

So, we will I am writing here these values will be calculated by Excel while satisfying the constraints ok. This is the objective function value, the objective function value will be calculated by Excel using the constraints and Min Max criteria. So, what we are saying here is that, the value of the objective function which will be which we shown here in the previous page exactly right here which was declared as a sum product aspect will be shown here, fine.

So, this value will be calculated by Microsoft Excel by itself and the constraints 1 2, 4 are setup right here. We just wrote the coefficients, the X e coefficients and X i coefficients here. This constraints says what X e plus 2 X i is less than or equal to 6, this constraints is 2 X e plus X i is less than or equal to 8 these are both the availability of the

raw material constraints. So, these two are the raw material constraint 1, this is the raw material constraint sorry my bad that is constraint 2 ok.

So, we have both the constraints raw material constraints there and these constraints says X minus X e plus X i or X i minus X e is less than or equal to 1, this is the demand constraint 1 and this is the demand constraint 2 ok. So, here we are saying that X i less than or equal to 2. So, this is the coefficients of this. This coefficients are set up in such a way that you can set up the LHS and RHS of this matrix much easily ok. So, that is the idea all right. So, the how do we do that we will see in a second but first and foremost what we have to do here is, we have to ensure that we have to see whether the solver is put it in the Microsoft Excel solver is there.

So, if we go to data and if you look at the analysis tool pack there is nothing called an analysis here. So, this tells you that the system does not have solver add in or the Microsoft Excel solver add in is not available with the system.

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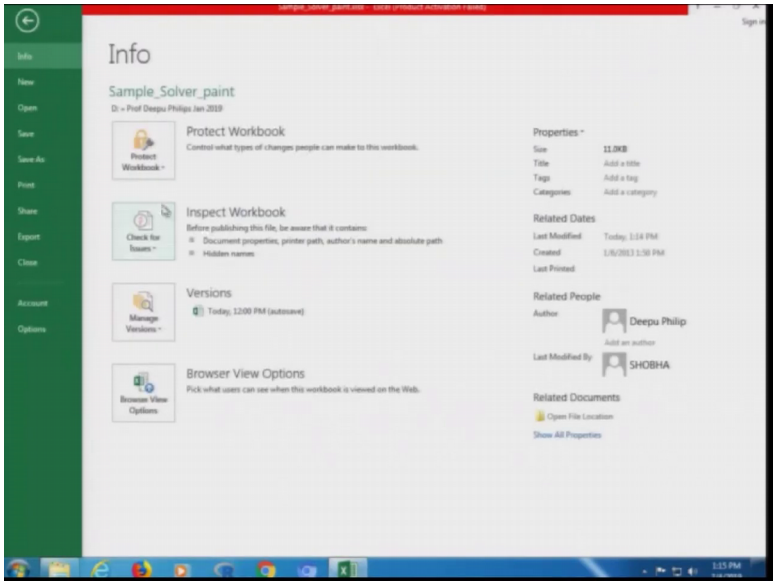

So, what do we do for that is first we go to the file option then a lot of tabs in excel. What you supposed to do is you are supposed to click the options tab of this. So, you can as I told you earlier this is Microsoft Excel 2010, so, it will be different from the Excel 2007 video that I was showing you earlier. So, the minute you click options this is going to change. So, please watch ok.

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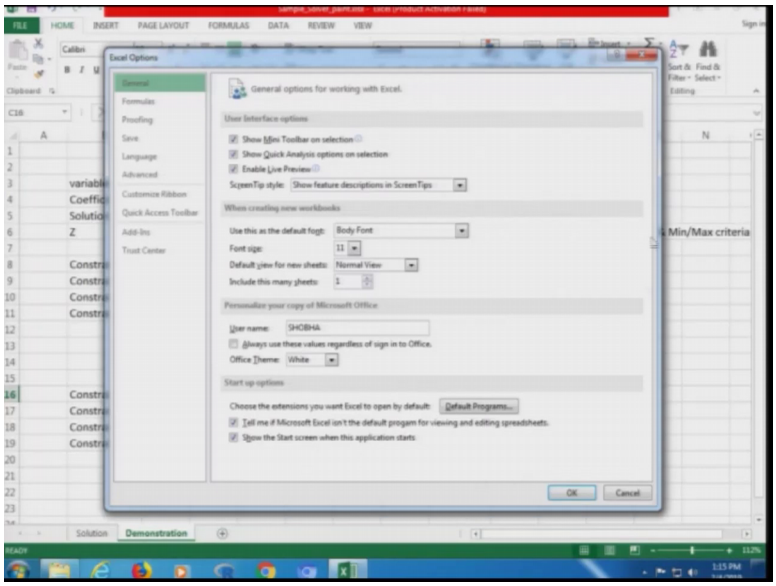

So, when you click this, a new box, a popup box comes out in this regard. There is general tab then there is formulas tab ok.

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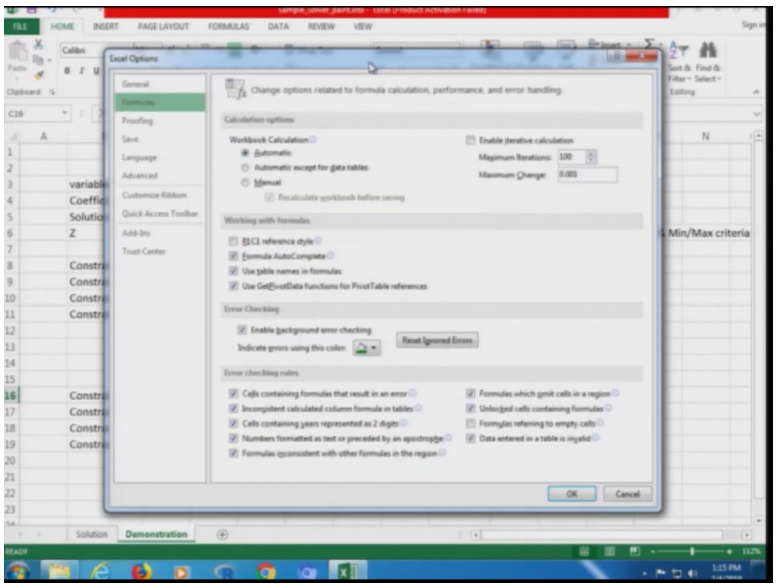

Then there is proofing tab.

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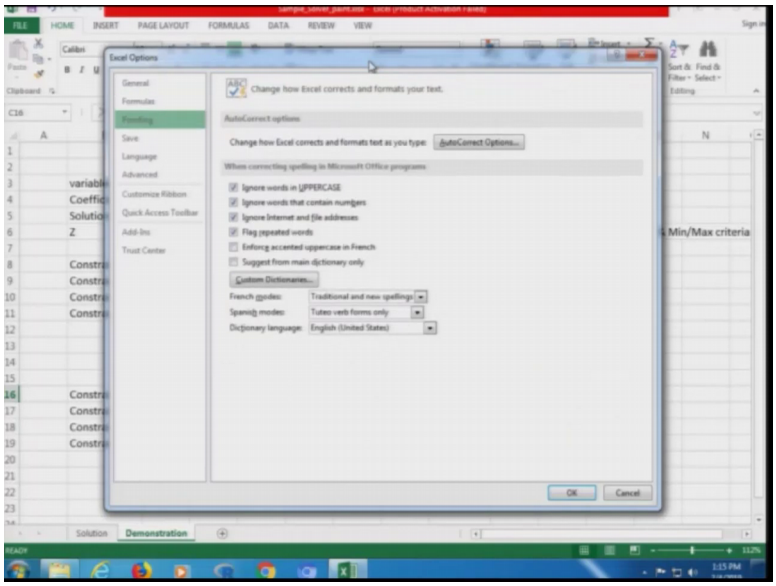

And you go by each one of the tab it will change things by itself.

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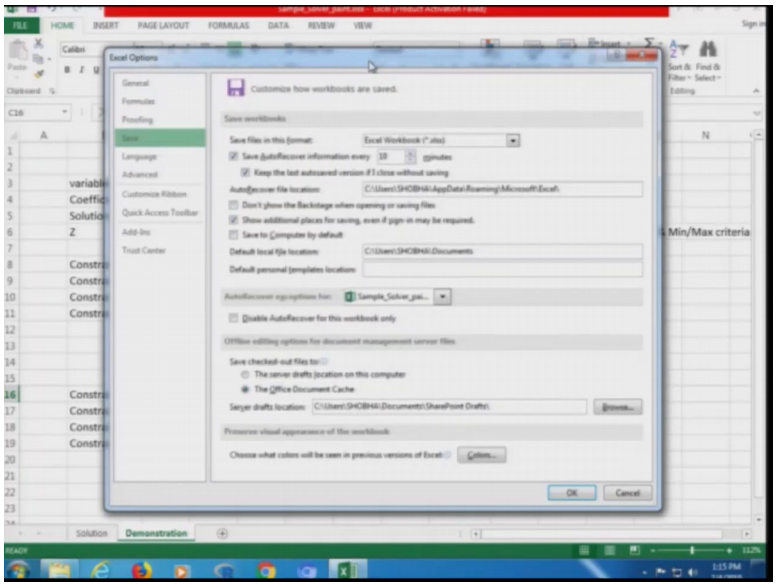

And what you are trying to do is, you are trying to get into the add ins tab ok.

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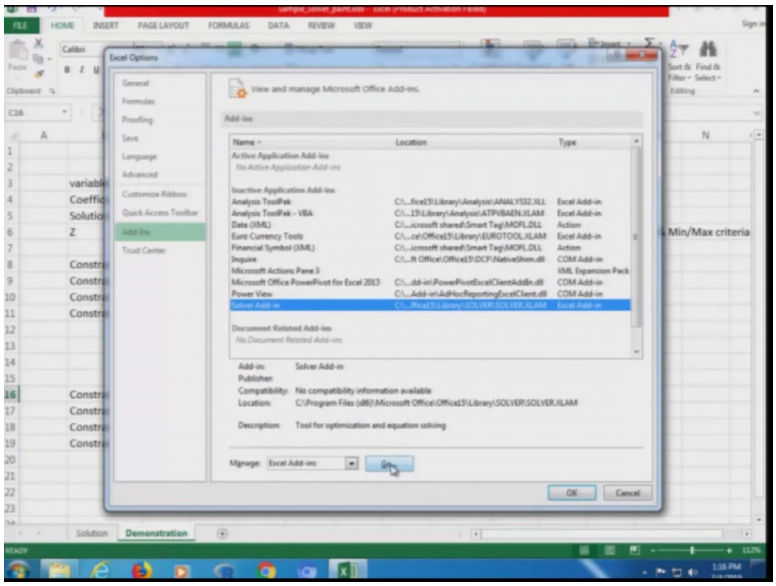

So, once you come to the add in tab, you have active application add ins, inactive application add ins and document related add ins. And remember what we told it was that we were looking into something called inactive applications add in the previous one and you look for what you call as a solver add in, which is available right here this is the solver add in. So, you click the solver add in right. The minute you click the solver add in, it actually says it says the manage Excel add ins or add ons and there is a button of go.

So, this is a tool for optimization equation solving and all other aspects that I share showed earlier.

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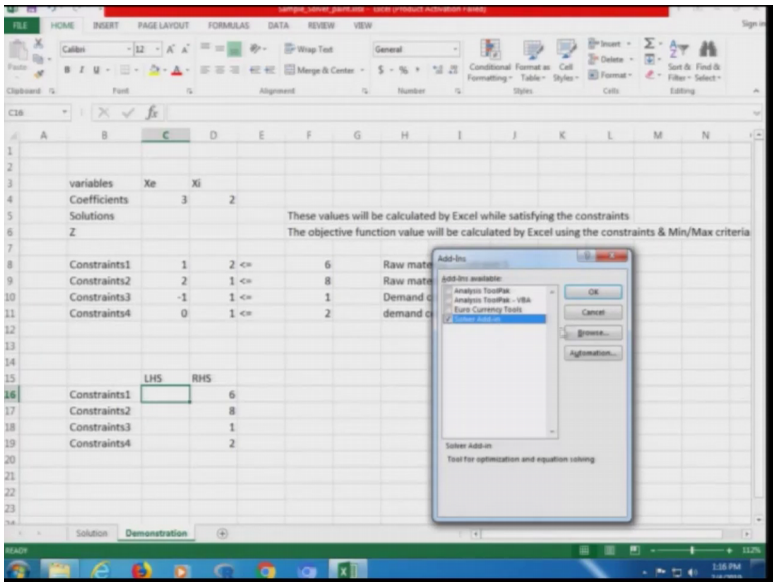

Say if I say go, it shows you these kind of four pages; earlier in the previous one I showed you this popup button will come up and I am not going to click the analysis to tool pack I am just going to do the solver add in nothing else ok. You can also click the analysis tool pack if you want to that is up to you, but I am just doing this solver add in for the time being click ok.

So, the Excel will do something it will do a preparing to install and it will do it will take a little bit of a period to do this, but please wait patiently at depending upon your computer and your version, Microsoft will take a little bit of time to do this aspect. But this is very important because many of the times most of the computers will not have this tool pack set up automatically ok. So, you will have to spend time little bit in setting this up. So, you please the reason I am shown you showing the screen to you is it will take little bit of time to do this and you just wait patiently.

In certain cases it might not even happen also and I we hope this will not happen here today, because it Microsoft you cannot really predict how it will behave today, but that is what it is it is supposed to install by itself. Sometimes if the computer is relatively new like I Microsoft 8 and you have a more memory a in computer, then this installation will be very quite quickly I mean like, but in all cases no matter what you are supposed to spend about 1 to 2 minutes in ensuring that this installation do happen.

So, we are we will just wait for the installation to happen at this time period ok. So, now, we are back to the square one we this installation has completed by Microsoft Excel and if you go to data, then you can see the new thing has come up called analysis and you can see there is an solver that has come up it will do the solve. So, I told you it will take little bit time. So, it is taken time reasonably good amount of time and so, now with this, we now, how to look into how the setup is there for us. So, the first and foremost is these values are filled by Excel and this was created as a sum product of C4 and d4 c C4 D4 is this and C5 and D5 ok.

So, sorry this is the sometimes some of the malware the right will actually keep on complaining that the solver add in that you are done is just a wrong thing to do, but do not worry that happens sometimes. So, we; So, I was telling earlier is this is a sum product of C4 d4 and c5 d5. So, we will do that here is we basically type equal to sum product of we have to say array the first one is our coefficients these two arrays ok. So, we will say these two you will say C4 to d4 comma c5 to d5 as the sum product for the time being it will show the value as 0 because these values there is no coefficients see that is nothing available right here. So, we are set up the first set which is the product sum product of these, which if you look in to this also it is exactly the same set up as this one right.

Now, our job is to set up all these LHS and RHS things ok. So, the first one we are going to say is, constraint 1 is says c 8 to d 8 take the values of c 8 d 8 multiplied with the values that you are going to put on c 5 and d 5 whatever values you are changing that. So, this is a sum product of these two columns. So, we are going to do that right here which is equal to sum product of we are saying. So, we require is these two cells. So, we will say c 8 to d 8 comma then we do not want the values to be changed in between.

So, what we are going to say is dollar value of a C dollar which is 5 to dollar value of D dollar 5 ok. So, we are saying that this is the sum product for you. So, the first constrain as if you remember again, it is a basically says is it is the sum product of these two coefficients X e and X i coefficients with whatever values we are putting there, and this the RHS side of it ok. We have done that so, far then that is done. Then we go to the second one where we can see that this is set up this way you are multiplying these two c 9 d 9 values with that of whatever the values that you are changing there in c 5 and d 5.

So, with that we will actually go to here and we will say equal to sum product of sum product of c 9 to d 9; you can see sorry my bad c 9 to d 9 comma you can see that these values are highlighted in this array comma, then we want to use the study values that are being used that is C 5 to dollar D 5 ok. So, the same as the previous case except that we are using the separate second set of constraints coefficients and we are multiplying it with whatever the value that Excel is trying to find out by itself ok. So, that is setup that way.

Now, what we do is we go to the third constraint ok. Third constraint if you look in to this, it is again set up as a sum product of the third constraint and the values that are shown there. So, we replicate the same thing right here. So, where we say it is a sum product of sum product of the 10th row that we are saying. So, C10 to d 10 comma and then we want the values of the c 5 d 5 whatever the values that we are putting there. So, we say dollar c dollar 5 to dollar d dollar 5 same as that of the previous constrain it gives you the 0 there.

Then we do the last constrain which is if you go here, which is shown as if you look into this, it is this sum product of these values the 11th column with that of the 5th row whatever the values that are been shown there. So, we go to here and we say equals sum product of we want the 11th row. So, it is c 11 to d 11 comma and we want it to multiplied with the fifth row. So, dollars c dollar 5 to dollar d dollar 5 you do that and we get all these values as zeros because there is no values are available here.

So, we have set up the. So, this is the setup of constraint matrix for optimization problem. So, this is the way I usually set up the problems so, that we can probably understand that the things are much easy for you to do ok. Once this is done what you need to do is, you can you want your answer to come right here in the z column. So, one of the things once you set all of these up you ensure that you click this column and go to body called as the solver ok.

Say click this solver, it actually shows the setup of the whole thing if you click the some other columns also it is fine. So, like for example, is we can see that has just picked up this column separately. So, let us say you did not do that, let us say you ended up clicking here somewhere here you clicked here somewhere and you say solver ok.

So, then if your confusion you can always come and click this place and say please show the answer there. So, that is another way to do this. I usually do this I just click this solver page and click solver there. So, that it automatically picks up the 6th page where the 6th cell very where is suppose to be your objective function. So, this is your objective function all right then as I said earlier we have already said whether it is maximization minimization or value of.

So, if you do a minimization, it changes this way if you do a maximization changes we can set a value of that also is to open. So, we are saying this is a maximization problem and what you are going to say here is, you are going to say by changing the values of c 5 and d 5.

So, normally this is Excel is very good at detecting things and it has also identified the minute you set up this kind of an constrained matrix, it will immediately identify that this is the constraint matrix that you are looking for, but I am going to just demonstrate how this constraints can be added in, I will show you how this constraints to be added in also.

So, by, so, we know that it is decided by changing the values of the cells, but you can also do it this way it will fill that value by itself. And then normally you will not have any constraints I mean ideally speaking, but when you set up a problem like this properly, then it Excel is good at identifying it they have added intelligence into it, but you can basically do by adding a constraint right here.

So, the cell reference you can say basic the first place you click here you can say all these guys ok. This is the first constraint this is the first constraint and then again this side whether it is less than or equal to equal to greater than or whatever it is, we are using the less than constraint and we do the RHS out of this which is basically this part right and we say.

So, the first constraint get added up I hope you guys understood this, I am just going to repeat this once again I click the add constraint it asks for the cell reference. So, the cell reference is where we take the LHS once where we have kept all the sum product constraints c 16 to c 19 all these values are put right there and then we say the less than or equal to or greater than or equal to according to; however, you are set it up and we are use the less than or equal to.

So, you put it there and then we it says what constraints need to be satisfied that is the RHS. The RHS values are populated right here very good ok. D 16 to D 19 ok. So, you have the first constraint C 16 to C 19 less than or equal to D 16 to D 19 that part is taken care of. The next constraint that you can add is add another constraint where we say that these values C 5 to D 5 both of them should be greater than or equal to value is you can type in value 0 also ok.

So, which that is your non negative d constraints the minute you do that constraint actually shows up right here C 5 to D 5 these two values these two values are non negative we can also here make unconstrained variables non negativity and click that, if you have any many constraints that you are not done. Instead of putting this constraint you can click this also it will also take care of it ok. And as I said earlier that there is multiple ways of solving this GRG non-linear is available then the simplex algorithm is available and then so, I is the evolutionary algorithm, but for us we choose the simplex lp in this regard and.

So, the this GRG non-linear is for solving problems that are smoke smooth non-linear functions, select the LP simplex engine for solving linear problems and the evolutionary engine for solving that are non smooth.

So, for our case it is actually simple linear problem. So, we are using the simplex one on this one, and what we do here is that then we click the solve button ok. So, once it is done we click the solve button and what happens now is that, the Excel has found out the values, 3.33 is the value of the X e and 1.333 is the value of the X i and 12.667 is the value of the objective function and you can see that the same solution has been created by xl right and.

We can also see the report also keep the solver solution and you can do all these analysis as well ok. And as you say click and you can see all these report are shown up right here.

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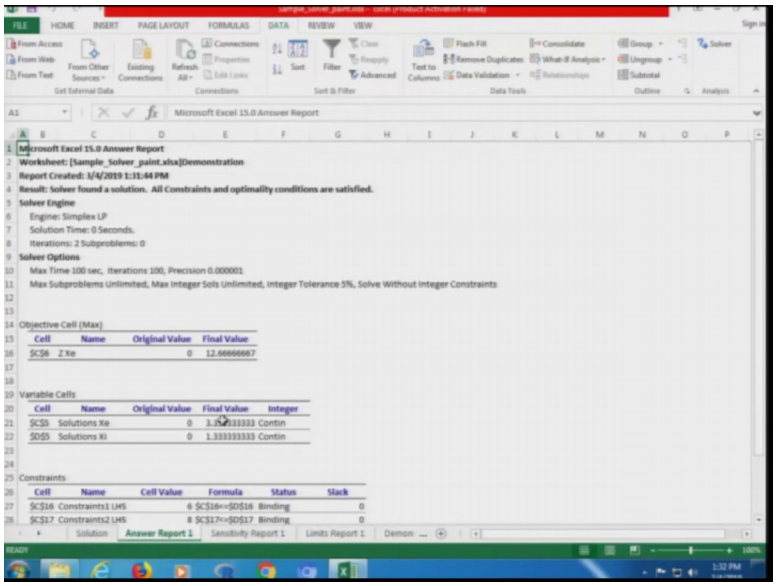

So, the answer report basically say is, how does the value was shown ok. So, if you look into this Excel sheet the time taken to this is iteration that two iteration; the precision is pretty high and you can see that this z value the 12.6667 is there and c 5 X e and X i for the solution is 3.33 their continuous values they are not integer values.

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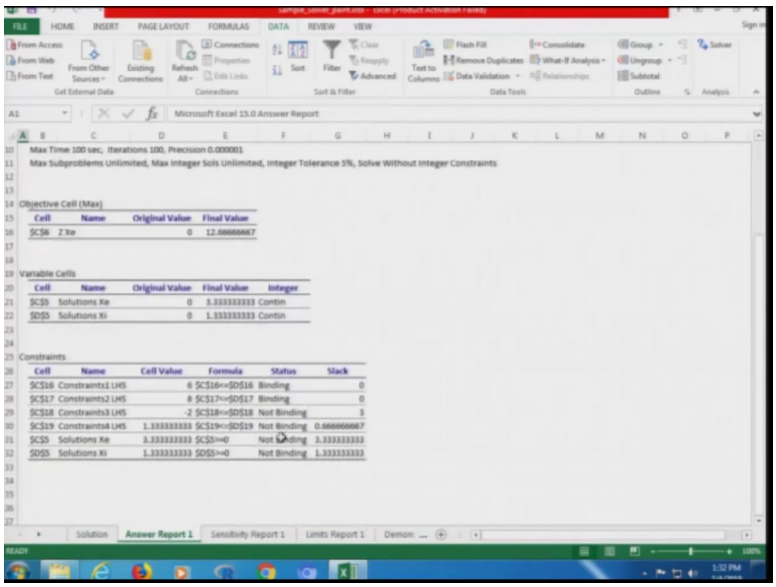

And the first constrains the LHS and RHS are binding constraint ok. Binding constraint means there is no slack absolutely no slack available; that means, they are full filled

totally. Then the constraints 4 and 5 are LHS or nonbinding which means they have slack means there is still a some more way for you to go with that.

And you can see that the values of the non negativity constraints are also satisfied. So, you can see all the 6 constraints are satisfied as part of this ok.

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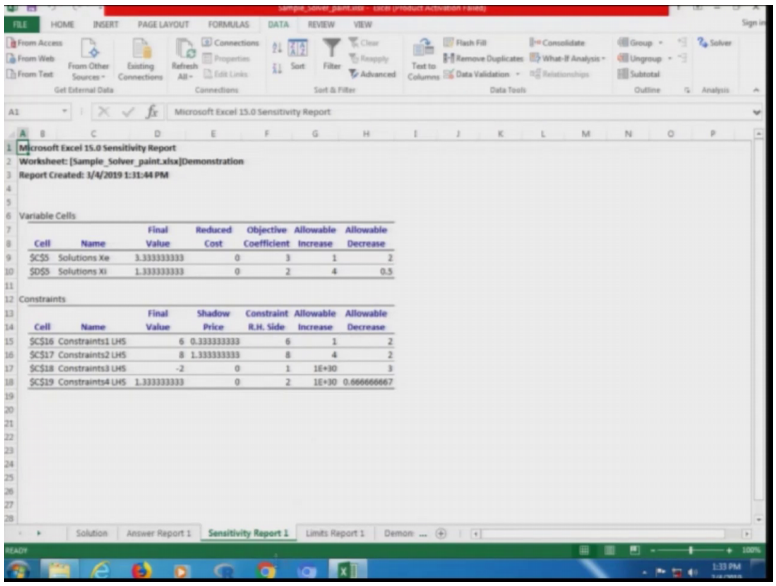

And we can also look at the sensitivity report which actually says the sensitivity analysis is that X e and X i the final values of these ok. The objective coefficient is three and two allowable increase is 1 and 4 and allowable decrease is 2 and 0.5 ok. So, that kind thing you can think about it before the constraints gets violated ok.

So, this is like the other parts of the solution, but this is optimal solution this is where you actually get them maximum value, but there is some changes that is possible in this, and we can increase this by one more and decreases by two more, but the answer will not be optimal in this.

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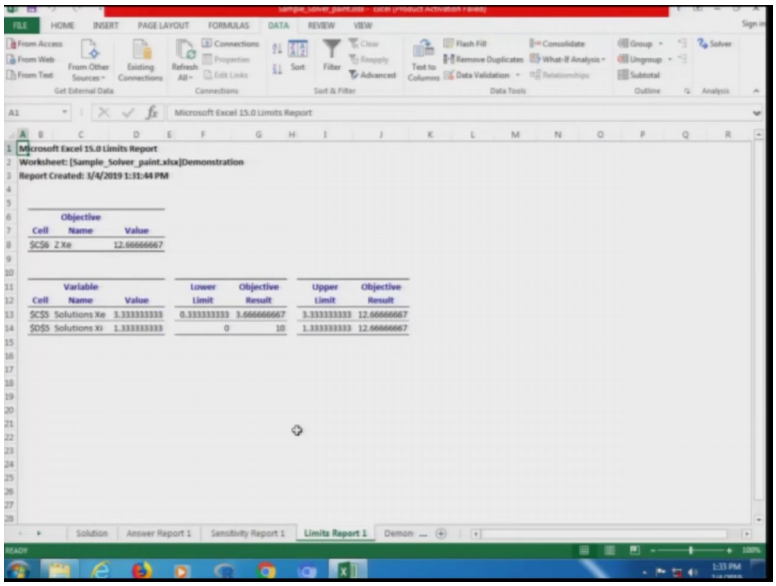

Then limits is another one is what are the limits of this right. So, the lower limit and upper limit is the 0.333 is the lower limit and upper limit is 3.6667 that is the lower and upper limit. So, you can the other one is 0 and 10.

So, within this value is this is a feasible region of the solution, any way that is something else for you to identify. So, these kind of reports are available, but for us these two values are the most important thing for us because what we are trying to say here is that, once we know these setup this is the one that gives the maximum usage and in the case of energy related problems we are going to say that these setting up or going to give us the maximum output while minimizing the energy, if the constraints were set up like this, then these are the values in which you would like the production machine to operate in most of the times.

So, I hope you get understood how the Excel can be used as a very good tool for doing optimization. This is a simple set up of the problem for an optimization and this Excel spreadsheet will be shared with you guys as part of the lecture material, you can use the Excel sheet and try this and download it and go forward with that. And the previous two problems that where created we will set up in such a way that, you can actually use Excel to solve that other two problems that you are also formatted.

It will be demonstrated by Prabal one of the TS of the course in this one. And in the next lecture onwards we will solve looking into what we called as the optimization algorithm,

some of the optimization approaches available how do you solve different type of optimization problems and what are some of them that are more popular in the green manufacturing area, when you are looking at optimizing multiple parameters like energy, metal removal rate, without compromising the throughput rate, minimizing the nonbiodegradable substances and those kind of stuff.

So, with that today we will conclude our lecture and please practice, there is no other way you can learn this without practicing this and once you once you are done with practicing this and you have expertise in this, you will be able to solve reasonably good optimization problems in this fashion.

Thank you very much.