Introduction to Accounting and Finance for Civil Engineers

Prof. Sudhir Misra
Dept. Civil Engineering
Indian Institute of Technology-Kanpur

Prof. Kumar Neeraj Jha
Dept. of Civil Engineering
Indian Institute of Technology-Delhi

Lecture-28
Bidding (part-7)

Good morning, namaskar and welcome to the course once again, in the previous lecture we discussed bidding models, in particular we discussed Friedman's model and Gates' model. These models we are discuss for 2 situations, in the first case we said that the identity of competitors are known and their numbers are also known. In the second case we said that identity of competitors are not known.

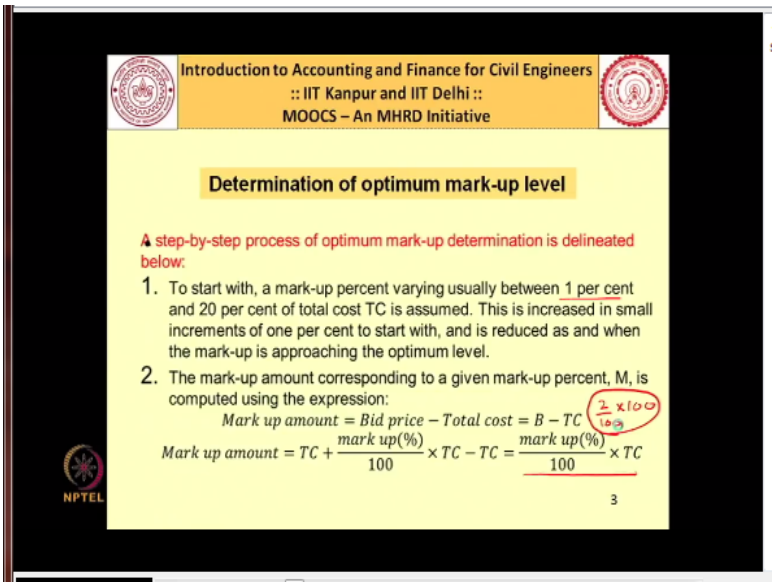
But their numbers are known, for these 2 situations we discussed the formulas given by both Friedman as well as Gates. We said that Friedman's model is giving us slightly lower value of mark-up as this is based on power model. So individual probability values are multiplied to get you the winning percentage, so in that sense it is slightly on a pessimistic manner. On the other hand Gate's model you find it is very closed to the real value and in fact these 2 models were subjected to lot of scrutiny.

And according to one researcher it was said that Friedman model is best suited when the difference in bid price is primarily on account of the mark-up. Now in this particular lecture we are going to discuss how to determine the optimal mark-up level, that means we are interested in finding that optimal mark-up at which the mark-up amount is maximum. We will find that when your probability values are I mean when you will find that when you mark percent is low.

Your probability of wining against that competitor is quite high, so your expected mark-up is still on a lower side. When you go on increasing this you will find the mark-up amount increases, you will find a point at which there would be a drop in mark-up amount. So, we are looking at that particular mark-up percent is at which the expected mark-up amount is the maximum. Now we

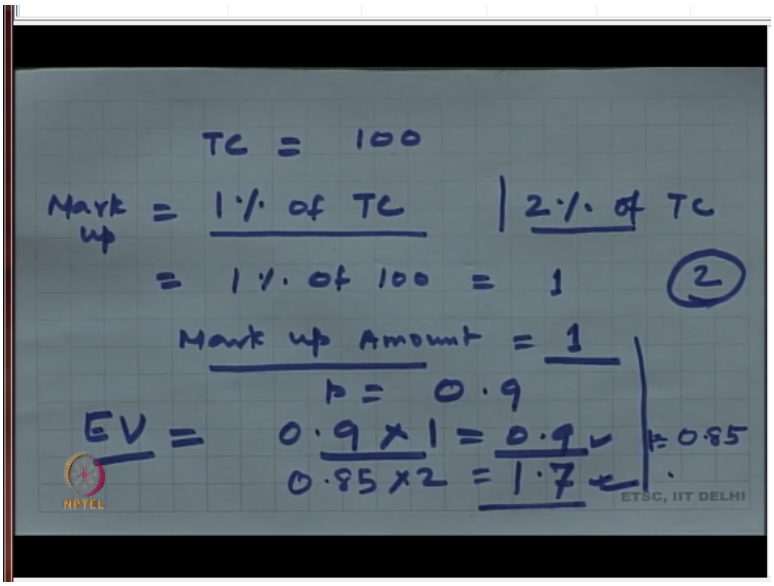
are going to do this in a step by step systematic manner. So we will first discuss all the steps and then we will give you one small example and we will illustrate how to determine the optimal mark-up percentage.

(Refer Slide Time: 03:05)



So, let us move to the various steps, in the first step what I do is I take very a small value of mark-up percentage, say it could be 1%. It could be 1% now for this 1% mark-up what I do is I calculate my mark-up amount how do I calculate the mark-up amount.

(Refer Slide Time: 03:30)



It would be done like this say for example your total cost is 100 right. You are saying ok I am applying 1% of total cost as mark-up let say you are saying mark-up as 1% of total cost. So, this

going to be 1% of 100 which is 1, so what is your mark-up amount, mark-up amount is basically 1 rupee. Now how do we calculate the expected value of mark-up amount expected value suppose the probability of beating this competitor at 1% is let say probability let say 0.9.

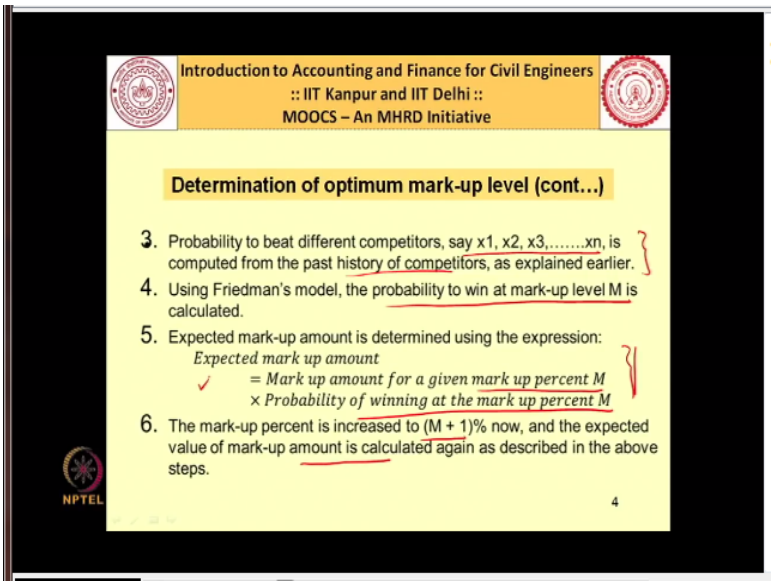
So, my expected value of mark-up is going to be 0.9 *1 which is 0.9. Now what I do I let us say increase the mark-up from 1% to 2%, so let us say this is 2% of total cost. So as before now this mark-up amount becomes 2 rupees now let us say when you increase this mark-up percentage your probability has slightly dropped. So it could be let us say 0.85 suppose, so your mark-up amount will become now 0.85*2 which is 1.7.

So, you found that when you coated at 1% your likely mark-up amount was 0.9 when your coating at 2% it is likely to go up to 1.7, likewise you will find that initially there would be an increase in the mark-up amount. But subsequently you will find that this value will come down, so we are trying to plot this curve and we are trying to locate the exact mark-up. Now this exercise we are going to do it for both the models.

We are going to do it separately for Friedman's model, we are going to do separately for gates model. In the previous lecture if you remember we said that the modern trend is to take the average value of the mark-up computed from both the models. So for the first case I am going to find out the optimal mark-up amount from Friedman's model, likewise I am going to do this for Gate's model and then at the end I am going to take the average.

And that is what I am going to apply on my bid right, so coming to the next steps now you know how to calculate the mark-up amount. I have explained you if you want to use the formula you can use it mark-up amount is mark-up percentage upon 100 multiplied by TC. So I gave you the example of 100 rupees total cost and mark-up I applied was 2/100. So, total mark-up amount was 2 rupees, so this is how we calculated for our 100 rupees total cost example.

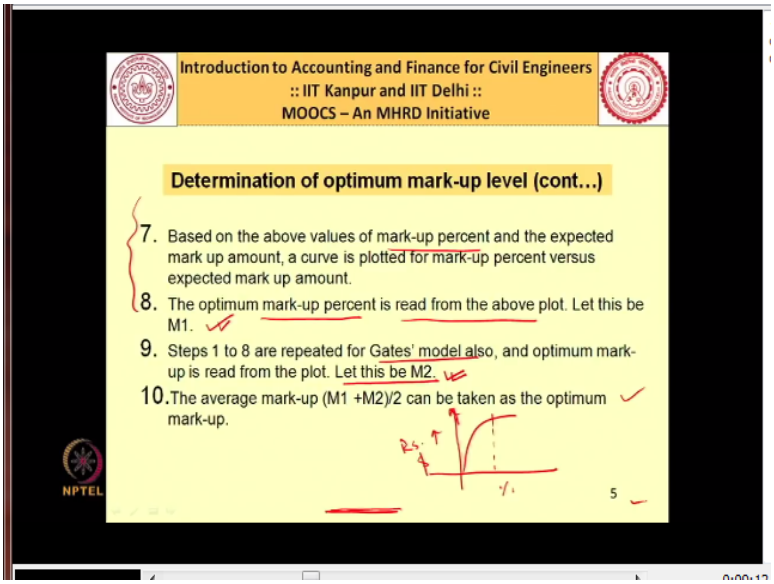
(Refer Slide Time: 06:39)



The third step I can calculate the probability to be different competitors say x1, x2, x3 xn from the past history of competitors as explained in the previous lecture. I will show you in this class also, then using Friedman's model I am going to find out the probability to win at mark-up level M, how do I do it, it is calculated like this expected mark-up amount is mark-up amount for a given mark-up % M multiplied by probability of wining at the percentage M.

You will see this how it is done now having done this I increase the mark-up from M to M=1 now. And the expected mark-up amount is calculated again as in step 5.

(Refer Slide Time: 07:29)

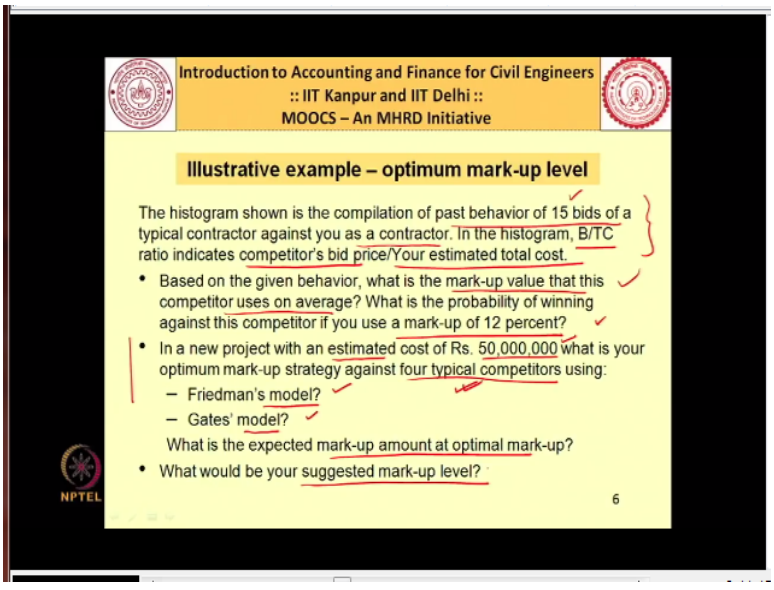


Then based on above values of mark-up percent and the expected mark-up amount a curve is plotted. So, you will find a curve will be plotted, so this curve will be plotted between which 2 variables 1 is your mark-up percentage, so on this axis you have mark-up percentage is 1%, 2%, 3% and n% and so on. And on this x-axis you will have expected mark-up amount, so money in terms of rupees or dollar would be on this axis.

Now having done this we can either read form the above plot what is the value of optimum mark-up percent or else you can do all these calculation in spreads it like xl and then you can directly get what is the optimal mark-up percent let this be M1. Now all these 8 steps what are you told now just now we do it for gate's model also. Gate's model is going to give you a different mark-up percent.

Because the formulas that we are going to use here is different and let us say the optimal mark-up that we get from this exercise we are getting it as let say M2. So, M1 I got it from Friedman's application, M2 I get it from Gate's application. Now as I told you in the previous lecture we will added it up, so M1+M2/2 and that is what we will apply in my total cost to submit a particular bid. So, this is the various steps which we need to follow.

(Refer Slide Time: 09:12)



Now we try to explain this these steps with the help of one small example. Now in the example I am given the histogram which is nothing but the compilation of past behavior of 15 bids. So, the

number of bids is 15 of a typical contractor against you as a contractor. So, you are the contractor and you have got the past data of 15 bids against a typical contractor. Now in the histogram B/TC ratio indicates competitor's bid price to your total estimated cost.

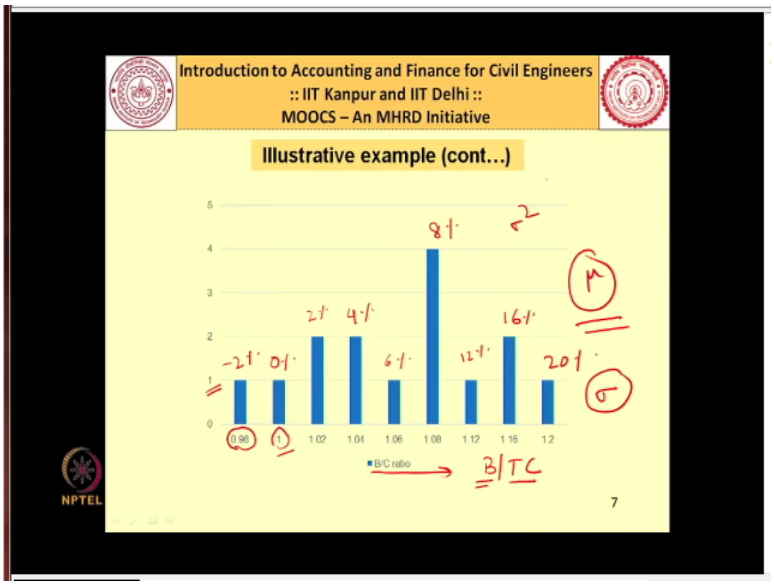
So, bid price divided by total estimated cost, now the question is based on the given behavior what is the mark-up value that this competitor uses on average. This is what you have to find it out mean value of the mark-up percent what is the probability of wining against this competitor. If you use a mark-up of 12%, so this is the other question. Now the next question is in a new project win an estimated cost of this much what is your optimal mark-up strategy against 4 typical competitors.

So it is saying that your coating for a project which is 50,000,000 project estimated cost, how much will be the mark-up percent that you will apply. If you are coating against 4 typical competitors typical competitors are showing up histogram like this of their bidding behavior. So, we are going to do this both using Friedman's model, Gates' model and we are also told what is the expected mark-up amount at the optimal mark-up.

And what would be your suggested make up level, so as you know the trend is you calculate the mark-up using Friedman's model also using Gates' model also and then you take the average to get the percentage, what is done here is we have been given a set of past data in which you as a contractor your cost and the competitors bid price details are given. You are told on an average what is the mark-up percentage that this typical competitor is applying.

Next question is what is the probability of beating this competitor if you are coating at let say 12% margin in your next project and the third question is in a project which you are bidding right now which estimated cost is 50,000,000 what will be your mark-up if you are using Friedman's model, what will be your mark-up if you are using Gates' model. And what would be your strategy, so these are the questions.

(Refer Slide Time: 12:09)

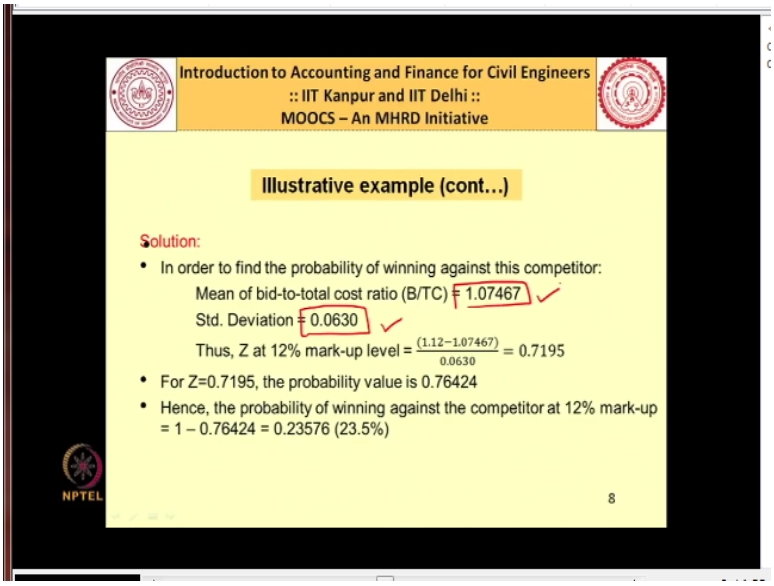


Now if you look at the histogram this is how it looks, so this axis is giving you B/TC. So, your competitors bid price, typical competitor bid price to your total cost, so you find that in one project the typical competitor coated 2% below your total cost 0.98. This is what 0.98 B/TC 1 in one project again it was coated at no profit no loss, B/TC 1 means the typical competitor did not apply any profit margin on your total cost.

In 2 projects they coated 2% higher than your cost, in 2 projects 4% higher than your cost, in 1 project 6% higher than your cost. In 4 projects 8% higher than your cost, in 1 project 12% higher than your cost, in 2 projects 16% higher than your cost. And in one project again 20% higher than cost higher than your total cost here it is 0% and her it is -2%. So, in terms of % now you know for these 15 projects, so the first question is what is the mean for this, that is not a difficult thing to calculate.

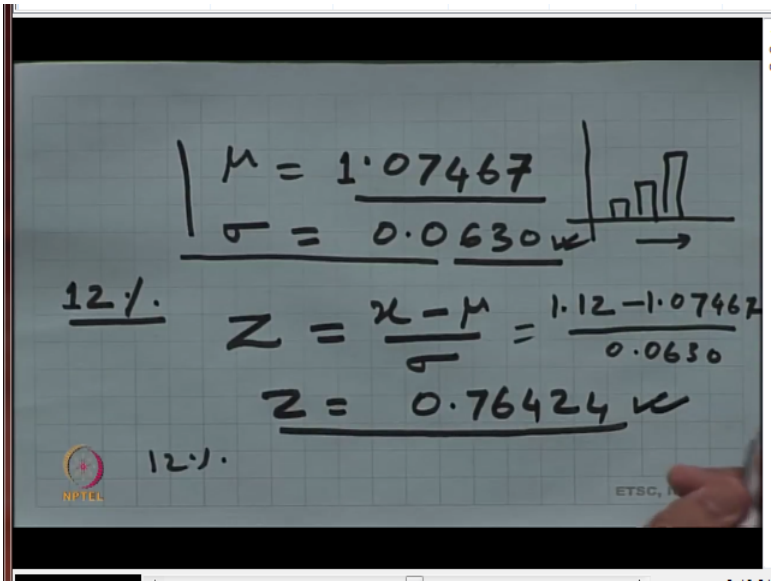
You can do it in a normal manner, you calculate the mean, so that gives you mean value. You have to also calculate the sigma, so sigma you will calculate it first by calculating sigma square and then by taking under root of that to give you the standard deviation, so I have calculated this.

(Refer Slide Time: 14:01)



And I am finding that the mean value is coming to be 1.07467 and standard deviation is coming to be 0.0630. These 2 values you can cross check it, so I find that my mean value for this particular example is coming to be 1.07467.

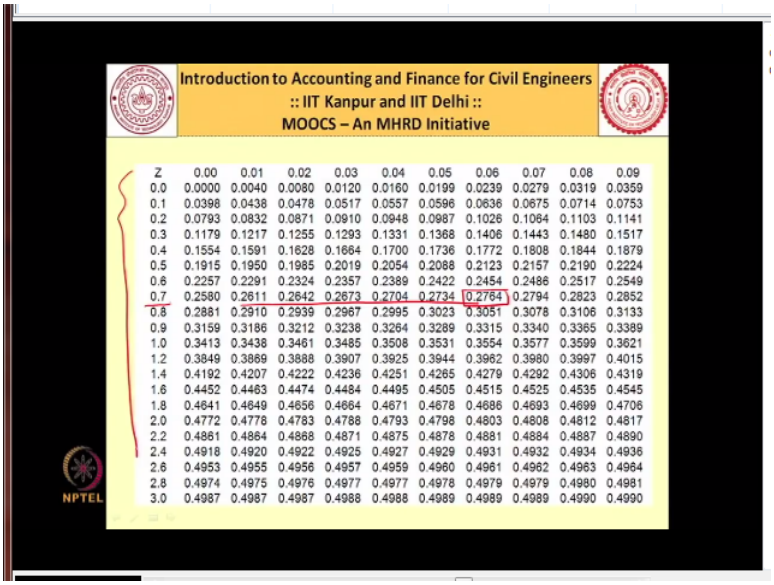
(Refer Slide Time: 14:24)



And sigma if you calculate it is coming to be 0.0630, so this first part of the answer. So, mean value and standard deviation have been calculated and from where am I able to calculate this, from these distributions. So I am given these distributions, so I take the average of those percentage and I am getting this and using the formula for variance and able to calculate the variance and thereafter the standard deviation.

Now the next question is what would be the probability of beating this competitor if you are bidding at 12% mark-up. So, I can calculate the value of Z, Z you know is x-mu upon sigma, now 12% x becomes 1.12 mean is what I have already calculated 1.07467 and sigma is 0.0630. So I am getting Z value as 0.76424, so this is my Z value. Now once you have got this Z value I can calculate the probability of wining against this competitor at 12% mark-up, for this you have to look at the normal distribution table corresponding to this value of Z.

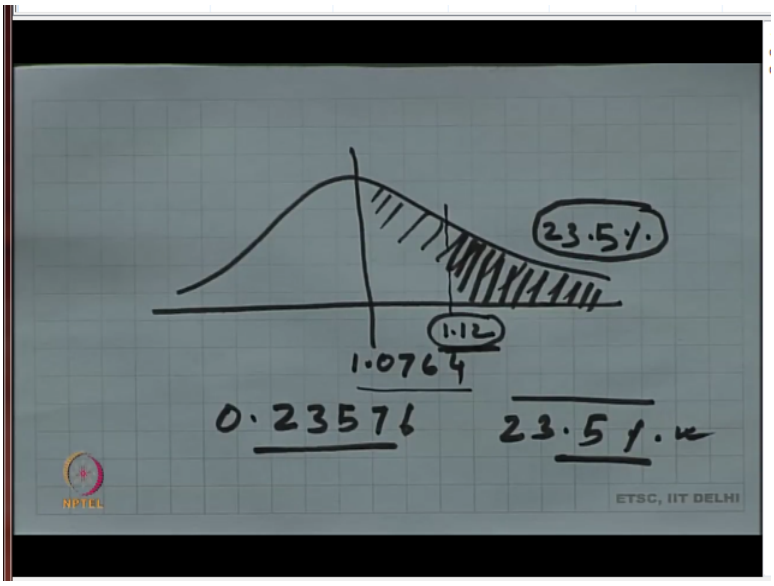
(Refer Slide Time: 16:03)



Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

So, if you see here is the value and in this table we can locate the Z value corresponding to 0.76. So, 0.7 is this row and you can find the value corresponding to 0.76 this is coming out to be 0.2764 right. So, from here we can calculate the probability of winning against this competitor at 12% mark-up, now just to give you an idea of this normal distribution it is like this and you have already calculated the mean value as 1.0764.

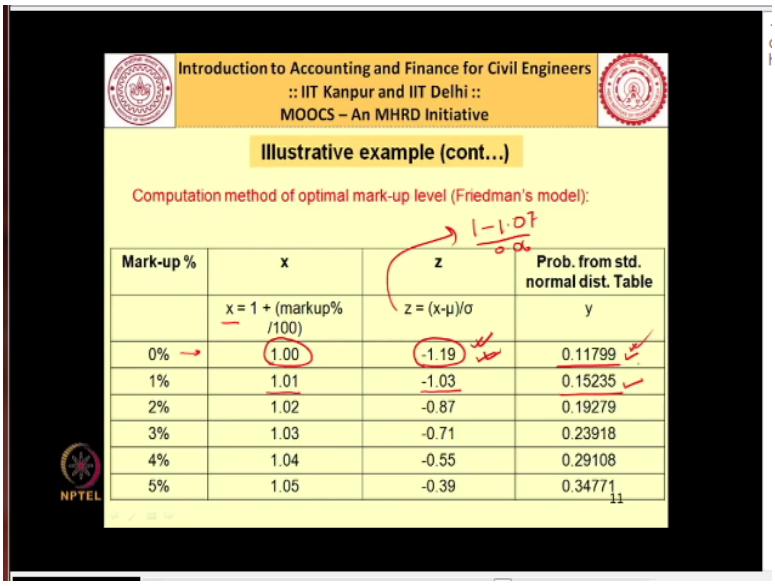
(Refer Slide Time: 16:48)



So, that means if you coat above this value you have a less than 50% chance of beating this particular bidder. If you are below this you have about 50% chance of beating this bidder. Now we are calculating it for 1.12. So, 1.12 will be somewhere here, so what is the probability of beating this competitor if you are coating above at 1.12. So, this value we are supposed to be finding and that way if you calculate we are getting the probability of winning as 0.2356 the other 0.23576.

This you can cross check this is roughly about 23.5%, so that means if you are coating at 12% the probability that you will be beat your competitor is 23.5% only right you can see here this is how you can calculate 1.0764 was the mean value here. And I am looking for a probability corresponding to x of 1.12, so it would be lesser than 50%. So, 23.5% is the value I got to beat this competitor at 12% mark-up. Now this was a specific to 12%, now as for as the third part of the problem is concerned.

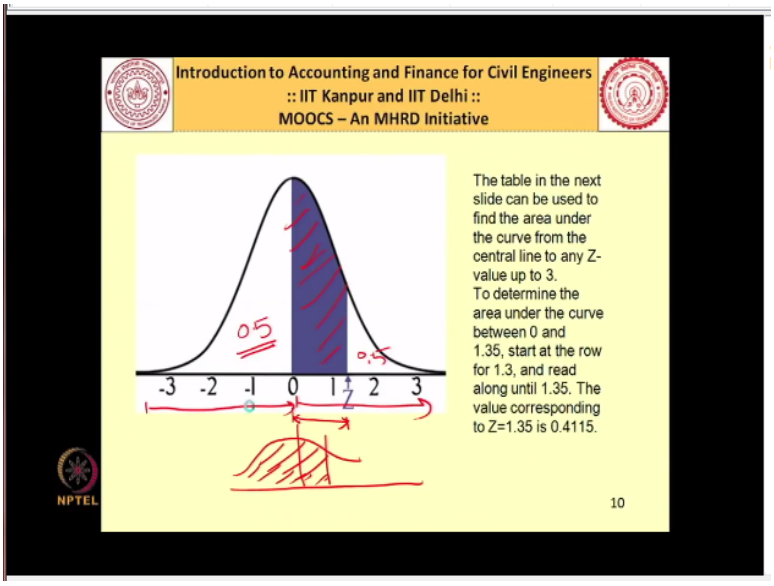
(Refer Slide Time: 18:18)



We can go a state to the table which I have prepared here now for this table what I have done is as I told you in a step 1 you have to take smaller percentage to mark-up to a start with and from there only you can calculate the expected mark-up value. So, let us say if the mark-up percent is 0% let us say I am bidding at no profit, no loss, so in that case my x is going to be 1. So, Z will be -1.19 how this Z becomes x-mew. So, x is 1, mu is 1.07 and standard deviation was 0.06.

So if you calculate this you will get in – and it would be -1.19. Now I can read out the probability from the standard normal table and it is coming to 0.11799 right. So that means the probability from this table.

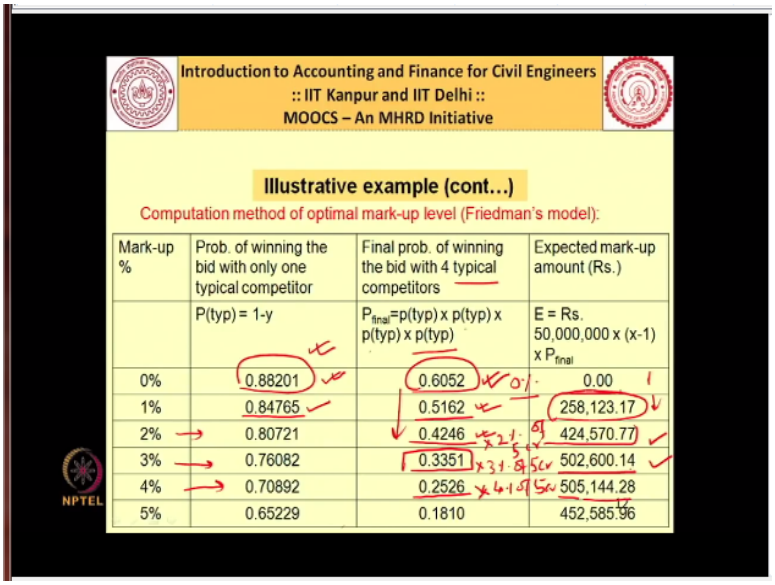
(Refer Slide Time: 19:24)



The table this particular table you can find it in my book construction project management theory and practice. And this table the figure would look something like this, the values are given are from this point onwards, so for a Z value equal to Z. We are measuring and giving you these values in this particular table some of the other books they will be giving you cumulative values. So, the value would be from –infinity, so if you are using this particular table you will have to add 0.5 also.

This is not added in my table you will have to add 0.5 because the area half of this area is 0.5 and half of this area is remaining 0.5 like this. This is 0.5 and this also is 0.5, so any value that you read it from this book you will have to add 0.5 there, so for example corresponding to Z of -1.19. You are getting probability value of 0.11799.

(Refer Slide Time: 20:28)



And so the actual probability value would be 0.88201 this you have to read it from the book and then you will have to derive this probability of winning. So this is at 0% mark-up, so what will be the probability of winning the bid against 4 typical bidders, this is only one. Now in the problem it is given that there are 4 typical competitors. So, I am using the Friedman model I am multiplying P typical with P typical with P typical with P typical 4 times.

So, if you multiply 0.88201*0.88201*0.88201*0.88201 you are going to get this value. So, this is the final probability of winning the bid with 4 typical competitors right. Now this probability I

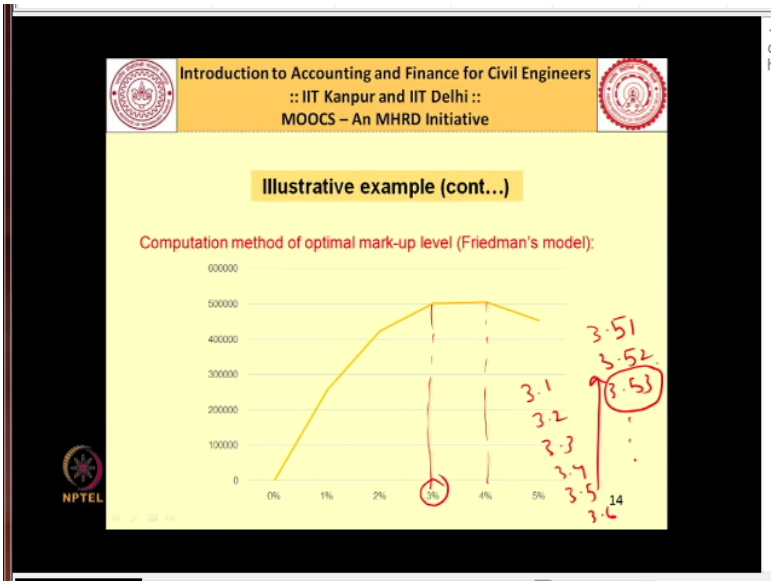
am multiplying with the mark-up amount remember we are coating at 0% mark-up. So, that means my mark-up amount is 0, so when I multiplying 0 with this 0.6052 I am getting 0 only. Now I do this calculation at 1%, at 1% my x becomes 1.01.

So, Z becomes -1.03 from my table I am reading 0.15235, so probability of winning against this bidder only one bidder is 0.84765. So, then I multiply this 4 times I am getting 0.5162. So, this value I am multiplying it with 1% of 50,000,000. So, 1% of 50,000,000 multiplied by 0.5162 I am getting 2,58,123, so you can see from 0 it has increase to 2,58000. Then I do this calculation at 2% probability of winning against 4 bidders is 0.4246.

Now what is this value, this is 0.4246 multiplied by 2% of 50,000,000. So, how we are getting this, this value multiplied by 2% of 50,000,000. I am getting 424, then I do this calculation at 3% I am getting the probability as 0.3351, so you can see the probabilities going on reducing. Because I am going on increasing the mark-up percentage, but my expected value is increasing in the beginning. How I am getting this value of 502,000.

This is 0.3351 multiplied by 3% of 50,000,000, I am getting 502, likewise when you do this at 4% probability has further come down 0.2526 when you multiply this with 4% of 50,000,000 we are getting 4% of 50,000,000. We are getting 505, so you find that initially the values are increasing and then they have come down.

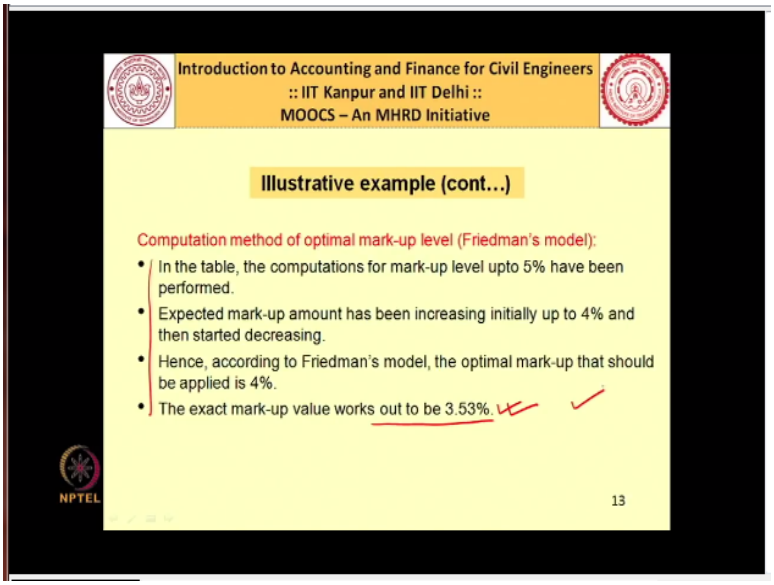
(Refer Slide Time: 23:30)



If you try to plot this you will get a graph something like this, so you can see at 3% it was somewhere here, at 4% it was somewhere here. Now once you know that there is a drop from here onwards you can increase the decimal places say right now you have taken the mark-up percentage at 3. Now you can take may be 3.1, 3.2, 3.3 and do the calculations again, till you find there is a increase and then there is a drop.

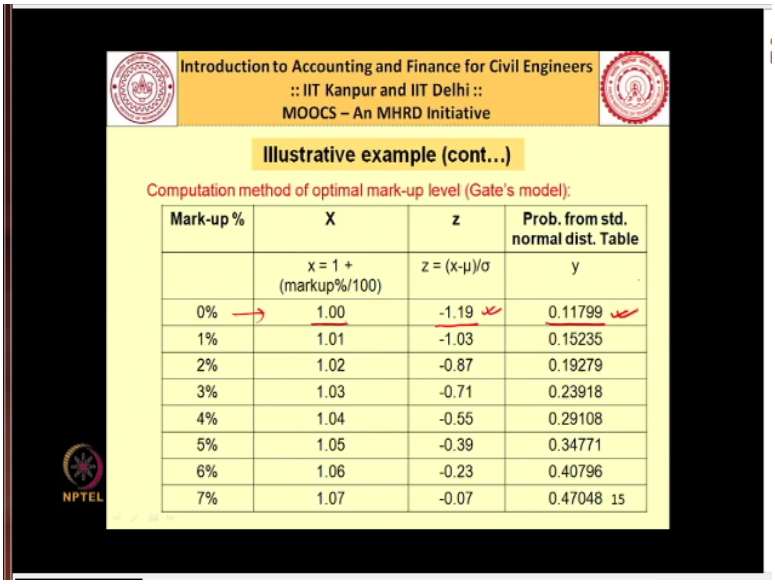
So, let us say between 3.3, 3.4, 3.5, 3.6 you observed that values have dropped, so then you take the further decimal places may be you can keep 3.51, 3.52, 3.53 and so on. So, you go and doing like this if you do this particular example in excel you will find that you are able to get the maximum mark-up amount against a mark-up percentage of 3.53.

(Refer Slide Time: 24:35)



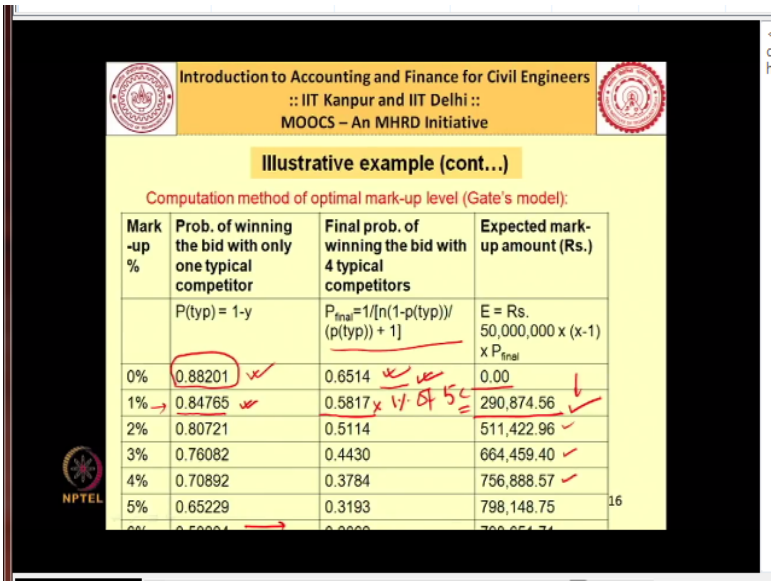
So, we are getting the maximum mark-up amount corresponding to a value of 3.53% this you can do it as an exercise in excel sheet. Now the same calculation what I have told you just now we have to repeat it for Gates' model.

(Refer Slide Time: 24:51)



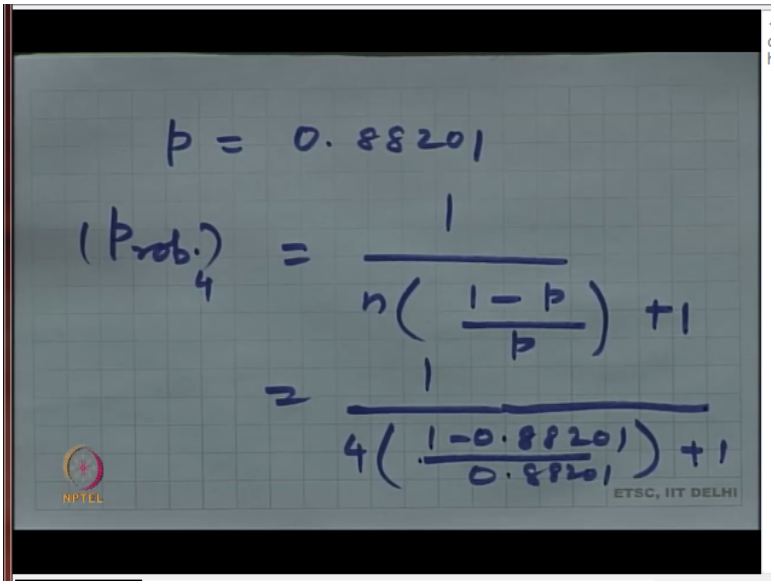
So, what I do I again start with 0%, so my x becomes 1, so my Z as before becomes -1.19 this value will also remain unchanged.

(Refer Slide Time: 25:03)



So, my probability of winning the bid with only one typical bidder, this will remain unchanged. Now there would be change here final probability of winning the bid with 4 typical bidders I am going to use this formula which is given by the Gates, 1 upon n multiplied by 1-P typical by P typical+1. So if you use this formula and if you use this P value as 0.88201 I will tell you how we have to use this.

(Refer Slide Time: 24:35)

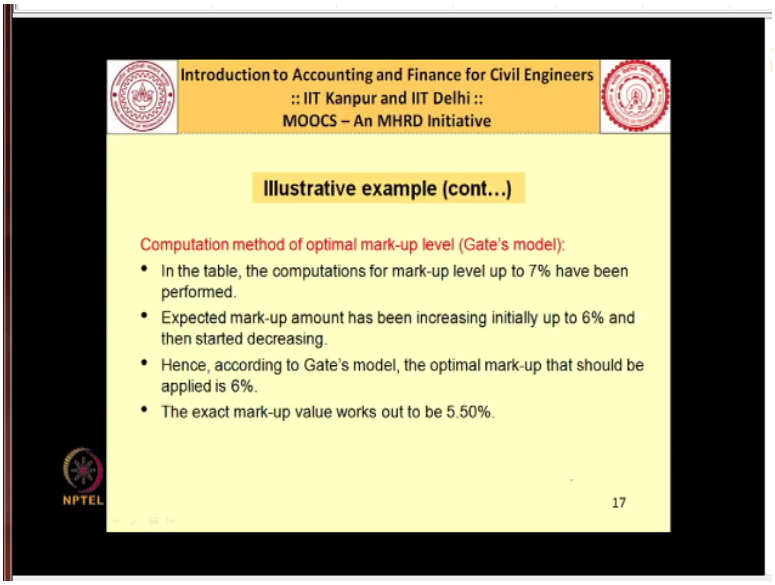


So, you will do it something like this p just now you calculated it to be 0.88201. So the probability of winning against 4 bidders will be given by 1 upon n*1-p upon p+1. So if you go on doing this 1 upon n in this case is 4 1-0.88201 upon 0.88201+1. You will get 0.6514 this is what is shown in this particular slide 0.6514. Now when you multiply this with 0% of

50,000,000 you will get 0, then you do the same calculation at 1%, for 1% the probability remains unchanged 0.847.

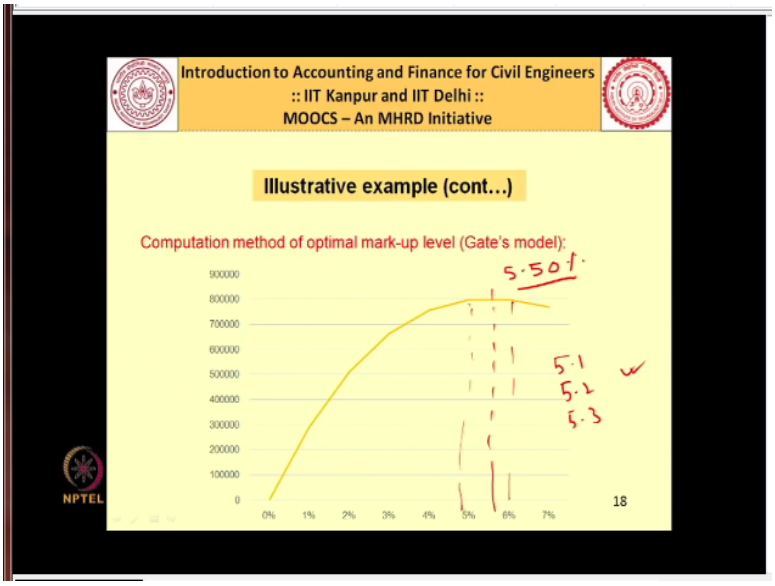
But the final probability of winning the bid with 4 typical bidders will be change if you are using Gates' model. Now this value multiplied by 1% of 50,000,000 you are getting 290,874. So, it has increased from 0 you do this calculation for 2% you are getting this value, 3% this value 4% this value.

(Refer Slide Time: 26:57)



Now you can plot this also as we have done in the previous case.

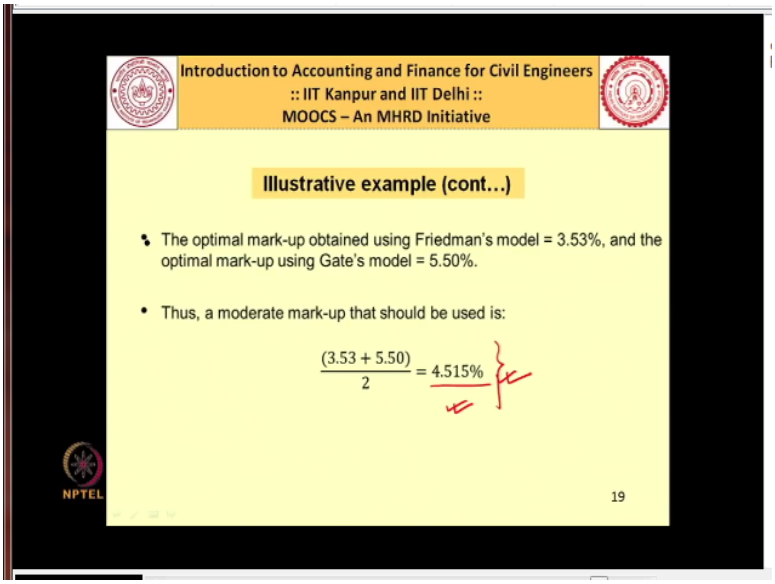
(Refer Slide Time: 27:00)



And you find that the graph would be something like this at 4%, 5% somewhere here, 6% somewhere here. So, peak is in between 5 and 6 %, so you can go and changing, so 5.1, 5.2, 5.3% we can take, then subsequently I can use 2 decimal places. So, you do this exercise in the same manner in which you did for Friedman's model you will find the optimal mark-up is coming against mark-up percentage of 5.5%.

So, what we discussed here is corresponding to Fried man model I am getting the peak at 3.53% corresponding to Gates' model I am getting the peak at 5.50%. Now in the previous lecture I have already told you that the modern trend is to derive the mark-up percentage using both the models and take the average. So, when I take the average of 3.53 and 5.5.

(Refer Slide Time: 28:00)



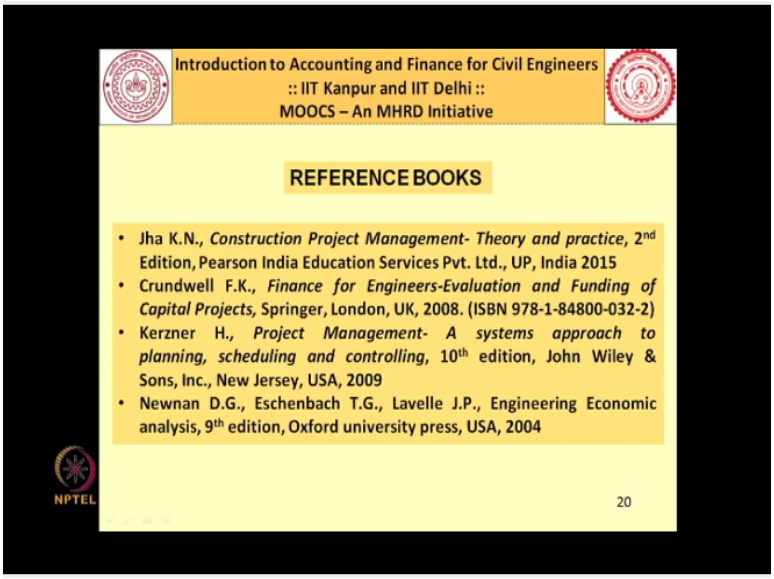
You will get a value of 4.515% and this is what I am going to apply in this particular project. So, this would be my strategy to apply for the next project. So in this particular lecture if I have to summarize we discussed all the 10 steps that we need to carry out in order to determine my optimal mark-up. So what I do I start with 0% mark-up I find the expected value of mark-up I increase the mark-up from 0 to 1, I again find out the expected mark-up.

Then I do this calculation at 2%, 3%, 4% till the time I get the mark-up percent at which I am getting the maximum mark-up amount. So, this I note it down for Friedman's model, the same step I carry on with Gates' model there also I get that particular mark-up percentage at which I

am getting the maximum mark-up amount. I take the average of these 2 mark-up percentage is and that is what I apply in the new project.

So this is all about determining bidding model that we had to discuss in this lecture. So this completes now a discussion on bidding process and our strategies to determine the bid price. In the next class we have to a start accounting which is the major part of this particular course and we will have different lectures pertaining to accounting part.

(Refer Slide Time: 29:32)



So till then if you want you can refer to these reference books thank you very much and see you some other time, thank you.