Principles of Construction Management
Prof. Sudhir Misra
Department of Civil Engineering
Indian Institute of Technology, Kanpur

Lecture – 13
Repayment of a loan

[FL] Welcome once again to these series of lectures on principles of construction management, and today we will be discussing some final details of repayment of a loan, which is important when we take a loan for a large project and try to gradually pay the amount. Part from that we will also briefly take up another example of calculating the net present value or the NPV from a given cash flow.

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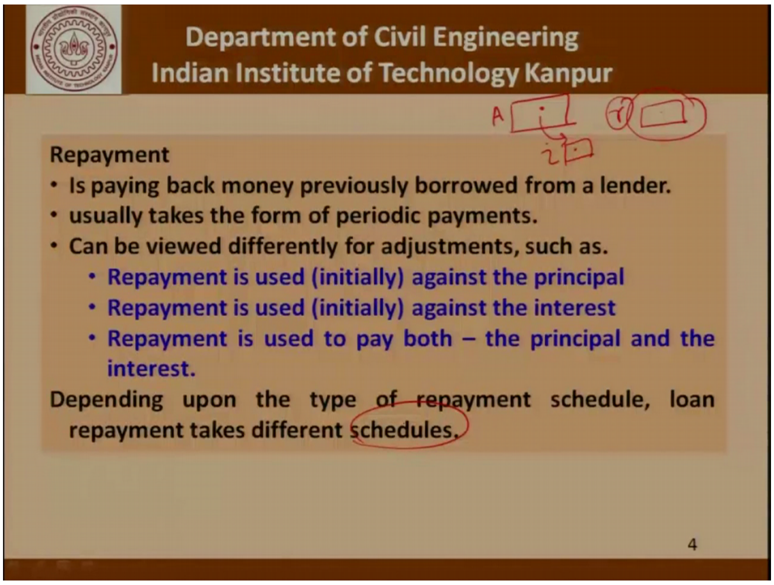

So, coming to the first topic for the discussion what is repayment. Repayment basically means it is the paying back money, which is previously borrowed from a lender. Usually this takes the form of periodic payments we do not make a lump sum return of a large loan, and the repayment can be viewed differently for adjustments such as the repayment is used initially against the principal, it is used against the interest and is used to pay both the principal and the interest. See what is being discussed is, that if we take a certain amount of loan let us say that is A and we make a repayment of small r which is something like this.

Now, the issue is that at the end of every year this A will accumulate a certain amount of interest. Whether this return that we make goes to pay the interest first or the principal or the amount first or this r gets distributed in paying the interest which is accumulated, and the principal that is what makes the whole arithmetic interesting and something which we must as a manager of a large construction project understand very clearly. And depending upon the type of repayment schedule the loan repayment takes different schedule, schedules here means the amount of time it takes to repay that loan.

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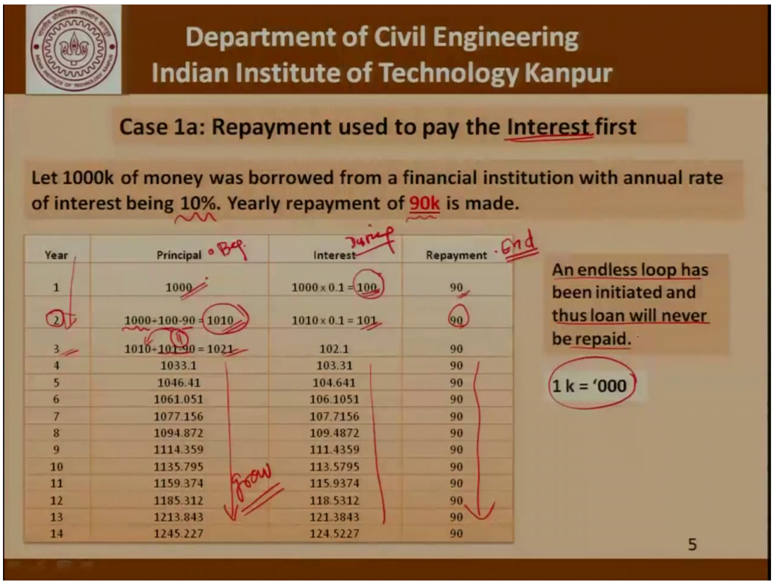

So, now coming to an example and that is the best way to go over this exercise, let us talk in terms of a one million unit. It could be rupees, it could be dollars whatever it is, one million units of money was borrowed from a financial institution at an annual rate of 10 percent, this rate could be any amount and let us say we are talking of a repayment of 90,000 every year. So, then what we are looking at is a situation like this. So, if we plot the years or if we write the years like this 1, 2, 3 4, 5, 6 and so on what is the principal at the start of the year that is what is listed in this column, and what is the interest that accrues on that principal during that year is what is listed here, and the repayment that is made at the end of this year is what is listed here.

So, the principal is listed at the beginning of the year, the interest is listed during that year and the repayment is being made at the end of the year. So, we can see that if 1000 units we are all talking in terms of a 1000 here. So, let us say there is a 1000 units. So, the interest being 10 percent will become 100. Now if the payment is only 90, then what is happening is that this 90 will be used as discussed here to pay the interest first. So, how much is the interest that has accumulated during this year it is a 100.

So, this 90 goes to pay this interest 100, which is 100 minus 90 and the 1000 the principle remains as it is because we if not made any contribution or any repayment of that principal and therefore, the principal at the start of year 2 becomes 1010. Now on this 1010 the 10 percent interest will apply and this interest is 101. Again if we make a payment of 90 we are paying this 90 towards this 101 and therefore, there is an accumulation of 11 units again and that is getting incorporated into the principle.

So, the principal at the start of year 3 becomes 1021 and so on. So, if we look at this scheme of things what becomes very clear is that the principal is continuing to simply grow, and in spite of the fact that we are making a repayment that repayment is not even sufficient to cover the interest. And because of that the principal is continuing to grow and what we have is that almost endless loop has been initiated and thus the loan can simply not be repaid.

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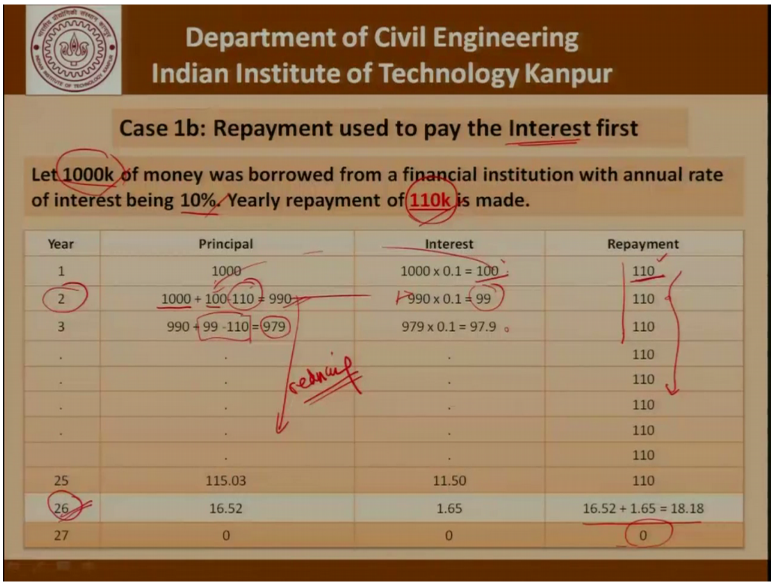

Now as against this if instead of 90, we make the repayment to be 110 with the same conditions of 10 percent and up billion units of loan being taken. Then we find that if the repayment is 110, this 110 will what is called service the interest of a 100 and the principal at the start of year two would be a 1000 plus 100 which is the interest which is accumulated from here, and less the amount of repayment which is made here which 110 and therefore, the principal becomes 990. So, this 990 will attract an interest of 99 and if we make this payment this will again make a small difference as far as the principal is concerned and this principal now becomes 979.

So, if this continues then we find that at the end of 26 years, we would be able to repay the whole thing off. So, effectively what is happening is that every time the repayment is being made, it is a little more than the interest that accrues in that year. And that little more is what is being counted towards the reduction of the principal which will attract the loan. So, the principal as a matter of fact in this case keeps reducing, but it reduces gradually as the difference between the repayment being made and the interest becomes larger and the interest is becoming smaller because principals becoming smaller.

So, this table shows us how much time it takes for the loan of a 1000 units to be repaid if 110 units is being repaid every year, and the interest applicable being 10 percent the rule applied is interest is being serviced first.

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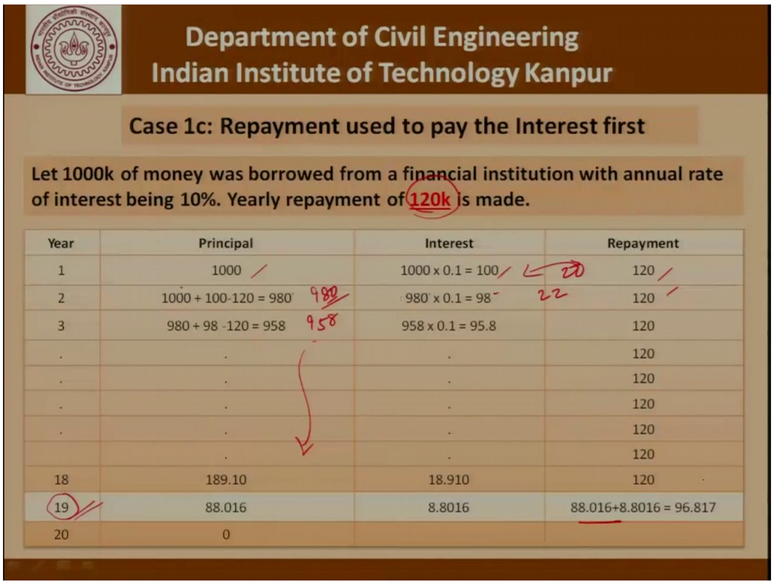

Now, as against 110, if we were to make a payment of 120 then; obviously, the time in which the loan is repaid will become smaller. The question is only how much smaller and that is something which becomes clear from this table, and we are able to get to 0 at the end of 19, the principal being applied being the same, 1000 units attracts 100 units we repay 120 and therefore, the remaining 20 between this and this gets transferred here. So, this 20 reduces the principal to 980 which attracts 98 and since we are paying the same amount the next time around it is a difference of 22, and this 22 reduces this 980 to 958 and so on and within 19 years we are able to come to a situation where we have repaid the loan.

So, with this cases we have illustrated how much time it takes for the loan to be repaid with the repayments being counted towards the interest payment first, the servicing the interest first and only the difference counting towards the reduction in the principal. We saw in the first example that if the repayment is not even meeting the interest requirement then; obviously, we are not repaying the loan at all.

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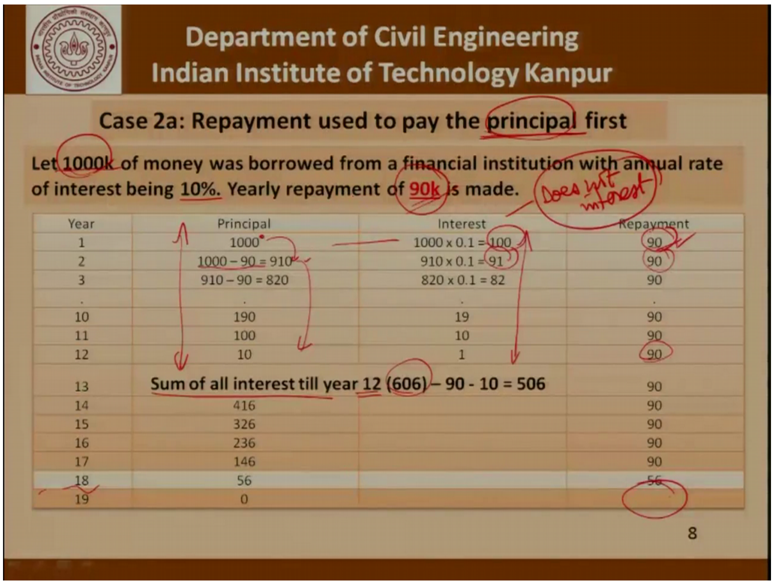

Now, let us come to the second rule, where we say that well the principal will be paid first. Now in that case if we have the same conditions that is 1000 units of loan being taken at the same rate of interest applicable, the same yearly payment of 90000 then because the principal is being paid first, the methodology followed here is that if the repayment of 90 is made that goes to simply reduce the principal, and this 1000 in the first year attracts an interest of 100, in the next year because this 90 has been paid and the principal is reduced to 910 the interest is only 91 again 90 speed. So, this is being reduced and obviously, since we are paying 90 against the loan of 1000 there will be a finite number of years where we can find out how much time it takes to repay this 1000.

So, what is happening now is that this interest is accumulating and another thing which we have done here is that this interest does not attract interest. So, there is no interest being accrued on the interest component itself. So, that is another rule that we have invented for ourselves, we have written down the conditions in that manner that the repayment will be counted towards the principal interest, not attracting interest. Now if that were the rules then the sum of all interest until year 12 is 606 and now we start servicing the interest component and within about 18 years we are able to come to a situation of 0 that is we have repaid the loan.

So, you will recall that if 90 was being paid in the rule that the interest is to be paid first, it was an endless loop where the loan is simply not getting repaid because this 90 was less than the interest accruing on the principal at any given point in time, but in this case when we say that the principal is being paid first then this 90 is getting utilized to keep reducing the principal and we keep adding the interest.

So, now having found that with 90 we are able to repay the loan in about 18, what happens when the repayment being made is increased to let us say 110 like we did in the previous case.

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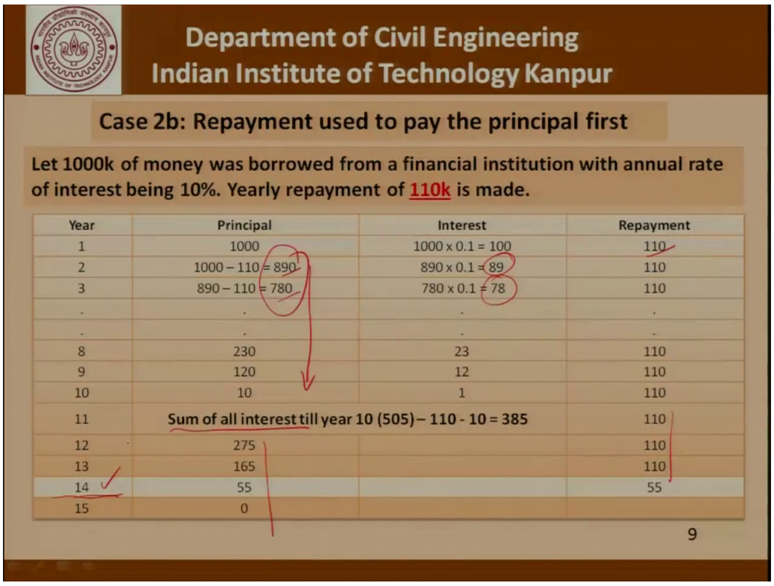

Year	Principal	Interest	Repayment
1	1000	1000 x 0.1 = 100	110
2	1000 – 110 = 890	890 x 0.1 = 89	110
3	890 – 110 = 780	780 x 0.1 = 78	110
.	.	.	.
.	.	.	.
8	230	23	110
9	120	12	110
10	10	1	110
11	Sum of all interest till year 10 (505) – 110 - 10 = 385		110
12	275		110
13	165		110
14	55		55
15	0		

So, now if we do that exercise we will find that the repayment is done in 14. So, it is the same thing 110 being used to keep reducing the principal here first, and this principal giving us whatever the interest is at the end of that year and finally, summing up all the interest and paying off that interest with 110 and we find that at 14 years we are through; the rule remaining the same that the interest does not attract interest.

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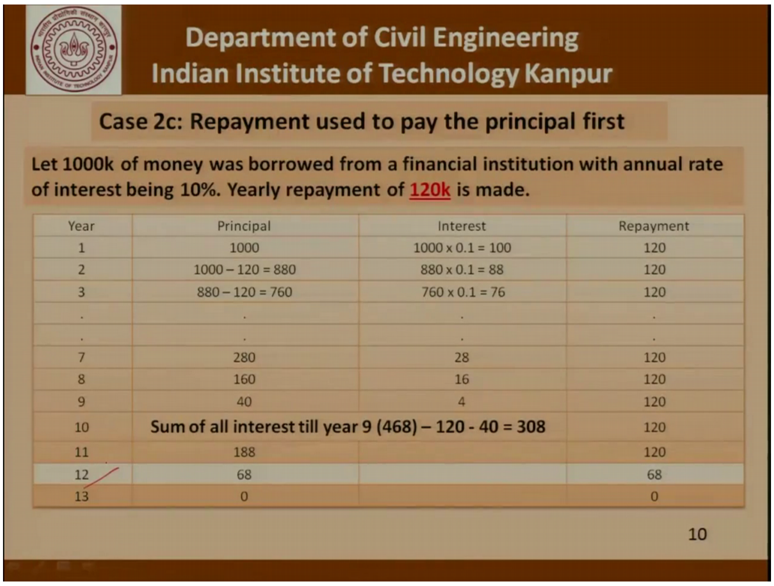

Now, as far as 2 c is concerned where the repayment amount is increased 220 we find that this repayment is over in 12 years.

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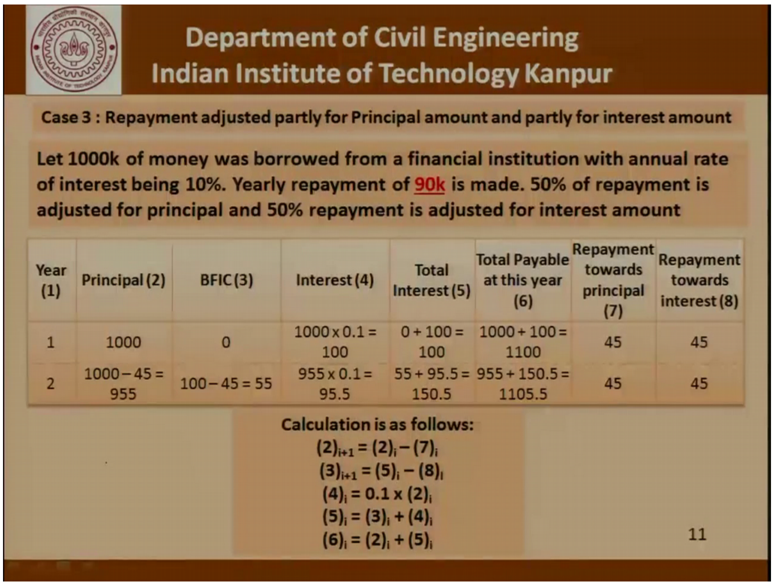

Now, is the third case we can take up the situation where 50 percent of the repayment is adjusted for the principal and 50 percent repayment is adjusted for the interest amount. So, this calculations I am not going to go into great detail and leave it to you to be able to carry out that exercise, it is a simple spreadsheet calculation and you please go through that and you will find that we are able to complete the repayment even with 90000 in 25 years.

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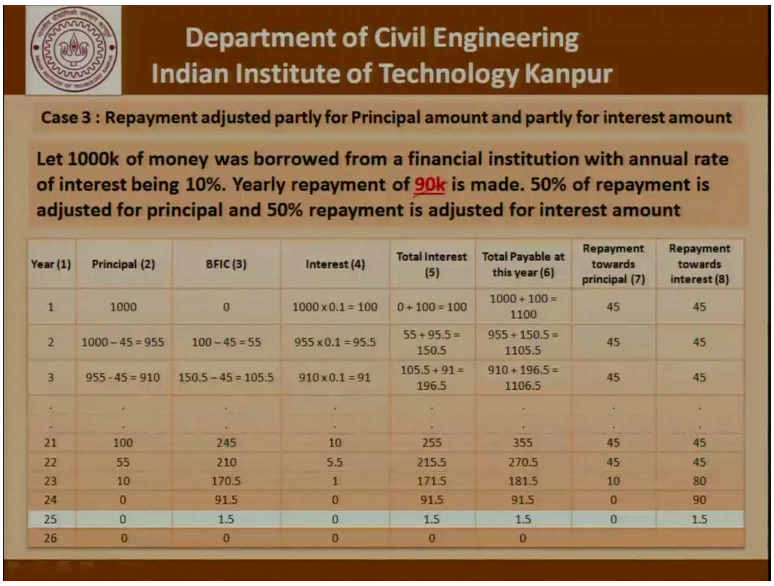

Again I would like to recall that with 90000 when all the repayment was being directed towards servicing the interest. It was not possible to pay the loan, but in this case since 50 percent of that is being used to reduce the principal and we are also invoking the fact that the interest does not attract interest, we are able to still repay the loan in a finite time.

So, continuing with this example if 110 was being paid the time reduces to 18 and if 120 was being paid it further reduces to 16.

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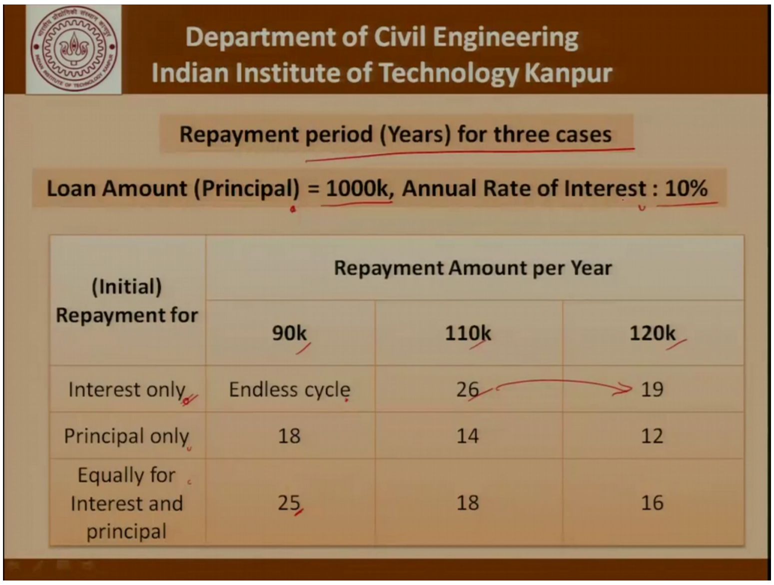
Department of Civil Engineering
Indian Institute of Technology Kanpur

Repayment period (Years) for three cases

Loan Amount (Principal) = 1000k, Annual Rate of Interest : 10%

(Initial) Repayment for	Repayment Amount per Year		
	90k	110k	120k
Interest only	Endless cycle	26	19
Principal only	18	14	12
Equally for Interest and principal	25	18	16

So, this table here shows the repayment period in years in the three cases. The first case being the interest being the primary responsibility that is the repayment is being used only for the interest first, the second beam it is used only for the principal and the third case was that the repayment is being equally divided between the principal and the interest. So, if we find from here depending upon the amount of money that we are repaying, for this 1000 unit loan at the interest rate of 10 percent, these are the number of years that it takes. If the interest alone is being serviced then here we have an endless situation where the loan is not getting serviced at all, and here it comes to 26, this is 25 this reduces from 26 to 19 and so on and so forth.

So, with this I think you have a fair understanding as to how to handle a situation using a spreadsheet, given the loan amount given the rate of interest and the rules of repayment whether the repayment is towards the interest whether it is towards the principal, what fraction of the repayment is being used to service the interest and the rule whether or not the interest component attracts further interest and so on.

So, with this we move on to the second part of our discussion today that is an illustration on the variation of NPV as a function of interest rate. We had discussed these concepts in the last class and this only an illustrative example that I thought well go through.

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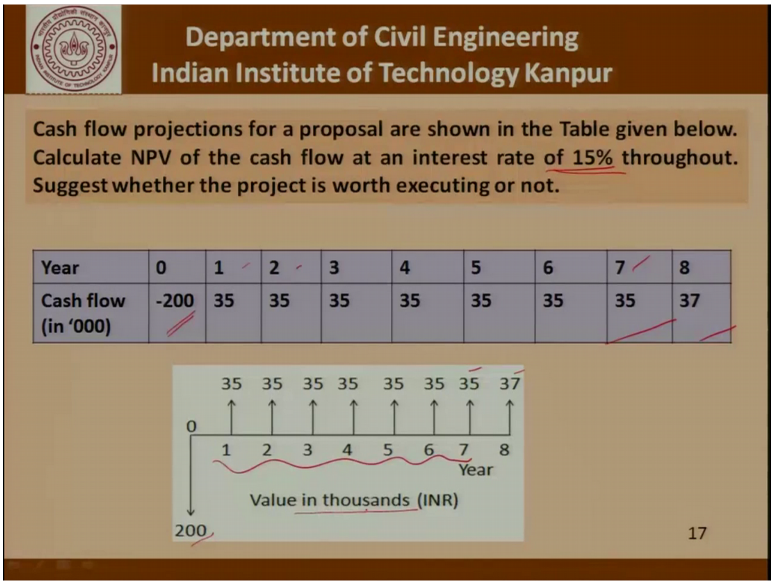

Let us say that the cash flow projections for a proposal are shown in the table given below, and we are required to calculate the NPV of the cash flow at an interest of 15 percent throughout, and we have to find out whether or not the project is worth executing.

So, what it shows here is that at the outset there is let us say an investment of 200 whatever the units are, and for the next seven years we have a revenue of 35, and in the 8 here there is a revenue of 37. Now the question is whether or not is this investment a good one or whether somebody would be recommended to do that. In order to make a decision we convert this information into a cash flow diagram which says that 200 spent and for the 7 years we get 35 and in the eighth year there is 37.

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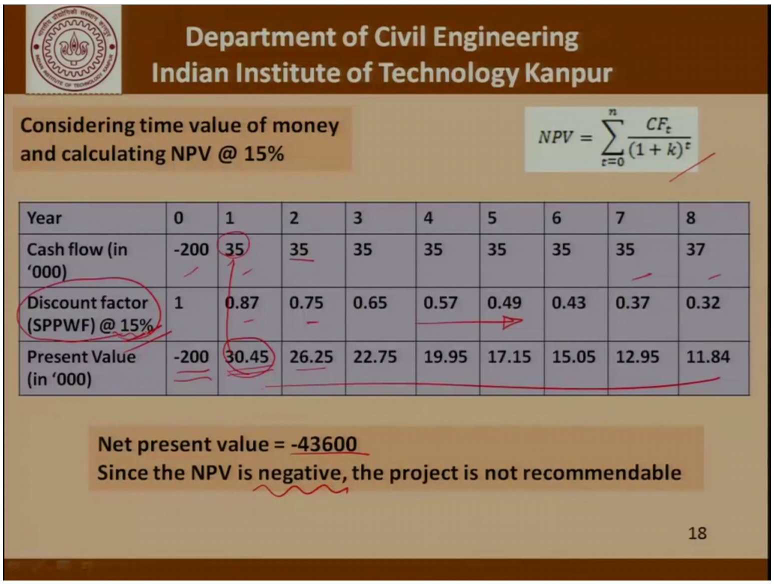

Now, our effort will be to find out the net present value of all these investments. So, how we do? It is using a table like this and this formula has already been discussed with you in a previous discussion and we find that the cash flow is minus 200 plus 35, 35 up to this point and a plus 37 here. So, what we find is the discount factor SPPWF at the rate of 15 percent what it says is that this does not change because this is where the investment has started, as the time goes on this factor reduces. So, what it means is basically that this 30.45 will grow to 35.

So, the net present worth of this 35 at the end of one year is actually 30.45. Similarly the net present worth of 35 at the end of 2 years is 26.25 and so on. Now if we sum up all the NPVS what we find is that the net present value is minus 43600. Since the value is negative the project is not recommendable that is it is not a good investment please remember that this NPV and these discount factors are for a interest rate of 15 percent.

Now, what happens if this interest rate was changed suppose the interest rate changes to 10 percent?

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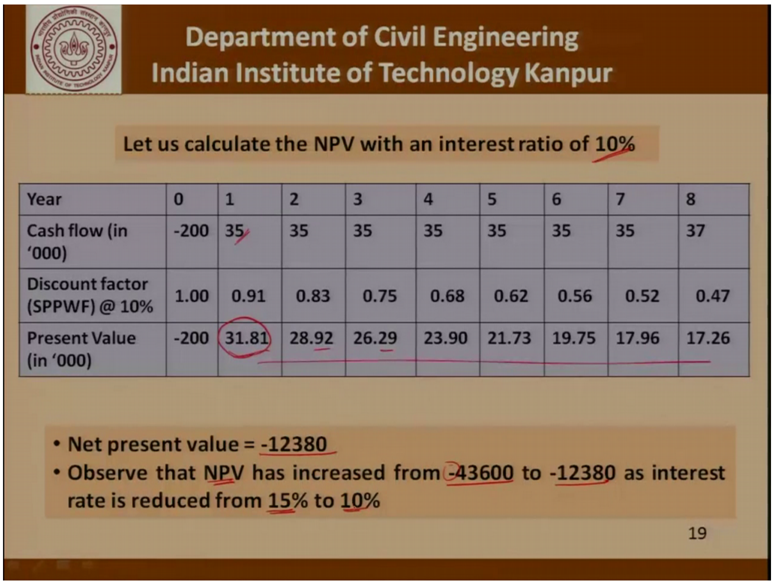

So, what we find is these values are slightly higher, what it means is that as far as a 10 percent interest rate is concerned you need a higher amount of money here, to grow to 35 with respect to the previous example. And if we do this exercise for all these amounts which is given for the 8 years, what we find is that the net present worth in this case is minus 12380 which shows that the NPV has increased from minus 43 to minus 12. So, there is an increase because there is a negative sign as the interest rate is reduced from 15 to 10 percent.

Now, let us carry this exercise further and do this calculation once again at 5 percent.

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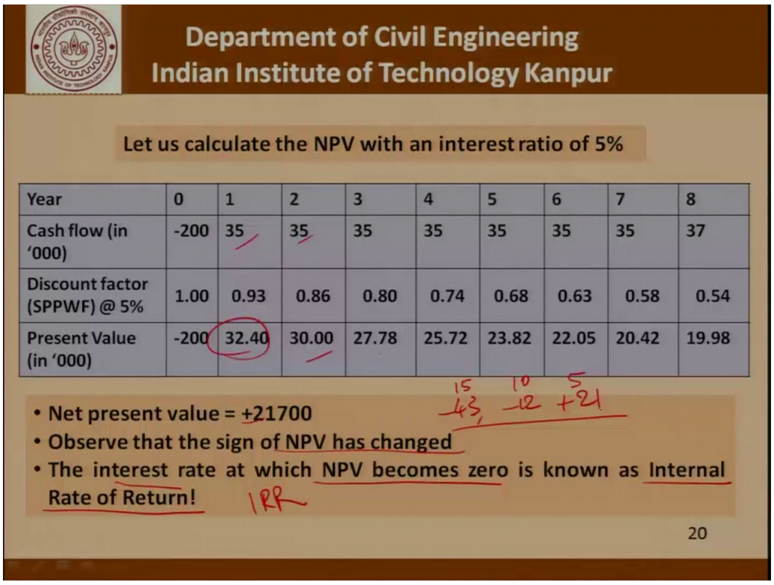

Now, what happens at 5 percent is that 32.04 is the present value for 35, 30 is the present value for this 35 and so on. If we carry out this arithmetic once again that is adding all these present values we find that the present value after summing up all these values is plus 21700, that is now the sign has changed. Previously it was minus 43000 something then it became well 1000 something and now it is plus 21. This has happened when the interest rate change from 15 to 10 to 5 percent

So, now we would also like to recall that the interest rate at which the NPV becomes 0 is known as the internal rate of return that is the IRR. So, what is the IRR for this example is something, which you can calculate given this information.

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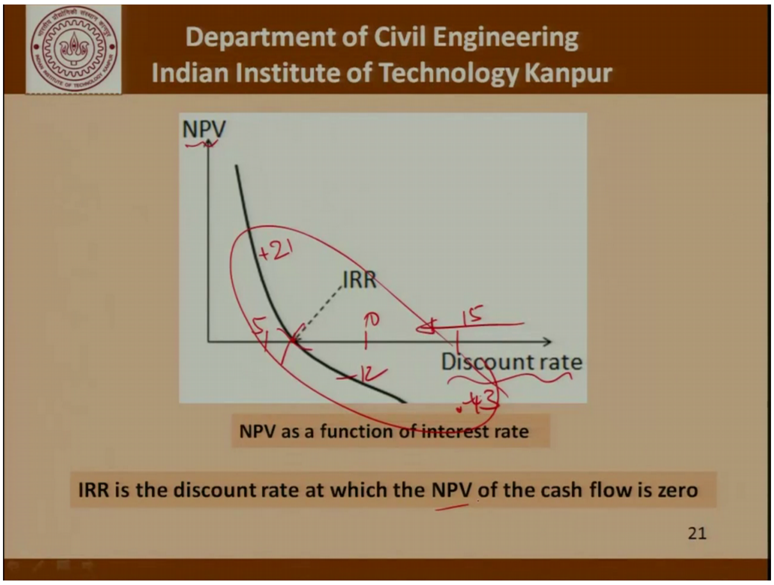

So, what we are plotting here is the discount rate versus NPV, as we reduce the rate of interest we did that for from 15 percent to 10 percent to 5 percent and we found that this number became minus 43 to minus 12 to plus 21. So, with this information we can find out at what interest rate the NPV becomes 0, we could do that graphically or we could simply do another iteration between 5 and 10 percent.

So, with this data we can find out at what IRR the NPV becomes 0. This we can do graphically or with another iteration carried out at an interest rate between 5 and 10 percent. So, to reiterate IRR is the discount rate at which the NPV of the cash flow is 0, having done that I would only like to show you the tables of interest rates which are readily available.

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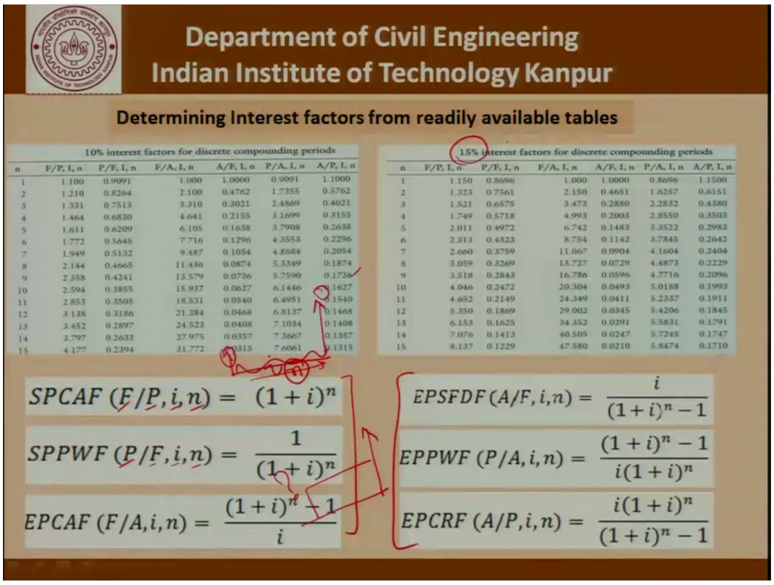

So, these are the tables or these were the factors which we had talked about in a previous discussion, when we said that what should be the F or what would be the F given P i and n, what would be the P given F i and n which was basically something like that, what should be the or what would be the final amount here if we invest a certain amount here at an interest rate of i and this was for a period of n or for example, if I want something here then what should be the amount here for the same i and n.

So, in order to help us do those calculations rather than using these complicated looking formulae these tables are readily available, and you can determine the factors from these tables. In fact, for the examples that we did today these tables are the ones that have been used and they are available for different rates of interest.

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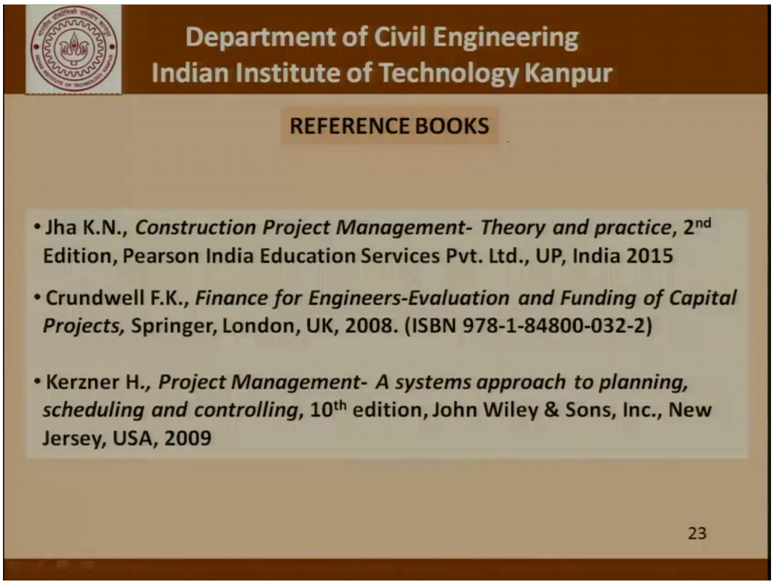

So, with this I come to at end of the discussion today, just reiterated the reference books which may help you understand the subject a little better, and I look forward to seeing you in the next class.

Thank you.