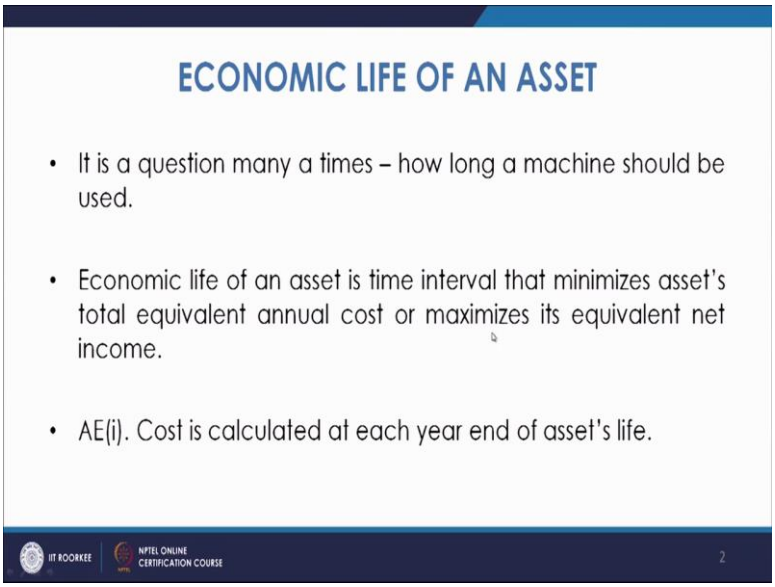
Engineering Economic Analysis
ProfessorDr. Pradeep K Jha
Department of Mechanical and Industrial Engineering
Indian Institute of TechnologyRoorkee
Lecture 20
Economic Life of the Asset

Welcome to the lecture oneconomic life. So we will discuss about how to find economic life of an asset. Now in economic terms when we use any asset, as the asset grows older the maintenance cost of the operating cost on the machine is increasing. So how long the machine should be used so that the annual cost you incur on the machine is minimum.

(Refer Slide Time: 01:24)



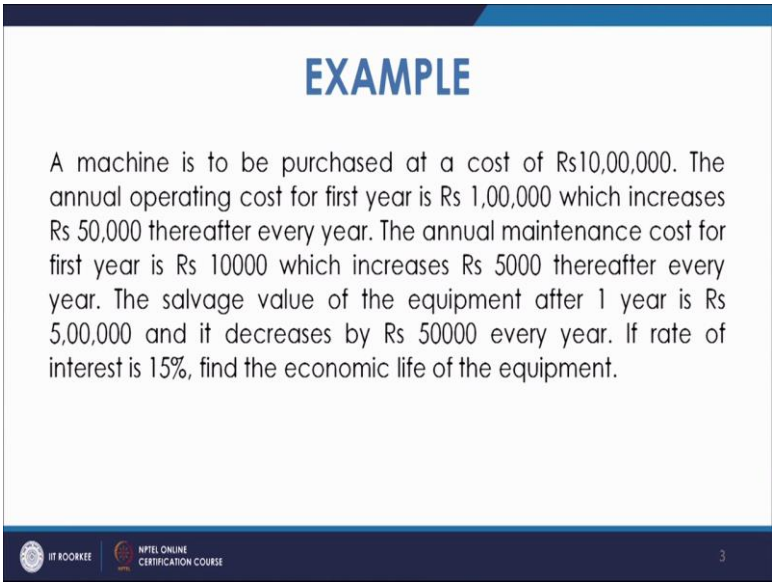
So basically the time for which you should use the machine where you get minimum annual cost is known as economic life of the asset. So we need to know how long the machine should be used which minimises assets total equivalent annual cost or maximises the equivalent net income. So basically you will be given with the first cost of the asset and salvage value at the end of every year.

Machine though when it will come it will have certain life total service life but every year the salvage value we go on decreasing. Now the salvage on one side which is decreasing, the operating and maintenance cost will go on increasing as the time progresses, this is the general trend when we use the machines. So basically for each of the years you have to use the equation to find annual equivalent value.

And the year in which this annual equivalent value is minimum if it is cost you can say that the machine should be used for that many years. Economically that is the best alternative and

that is why that time will be known as economic life of the asset or economic service life of the asset. Let us see how solve such problems.

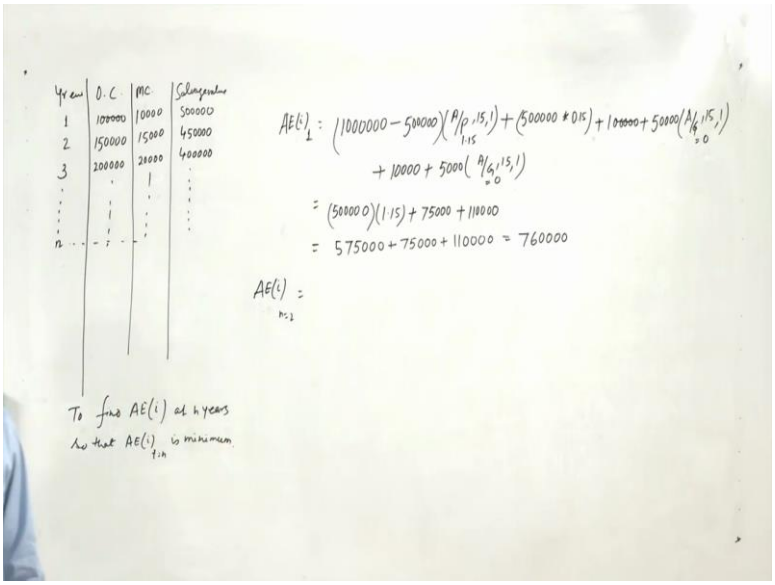
(Refer Slide Time: 03:06)



So a problem is given where a machine is to be purchased ah at the cost of Rs. 10,00,000. The annual operating cost for this during the first year is 1,00,000 and this is increasing every year with Rs. 50,000, so uniformly this amount is increasing. Annual maintenance cost during the first year is 10,000 and it is increasing 5000 every year, so it is also again uniformly increasing every year.

Salvage value of the equipment after one year is Rs. 5,00,000 and it is decreasing by Rs. 50,000 every year. So as we discussed that salvage value if we dispose the machine after one year it will be 5,00,000 but every time every year you use it the salvage value will go on decreasing. So at the rate of 15% interest, we have to find the economic life of the asset. So what we can see is we have to calculate the annual equivalent value.

(Refer Slide Time: 11:12)

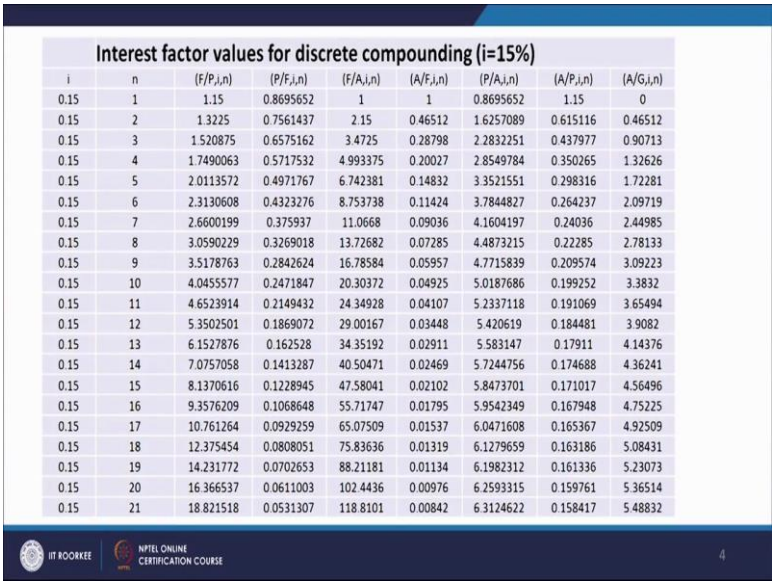


Now this is year end, so you if you take the first cost of the asset as 10,00,000 but then its annual operating cost is 1,00,000. So operating cost in the first year it is 1,00,000. The second year it is increasing 50,000 so it will become 150,000. The third year it will be 2,00,000 like that, so it will go on increasing. Similarly maintenance cost again this is annual. Maintenance cost is 10,000 and it is increasing every year 5000.

So in this year it will be 15,000, 20,000 and this way it will go. Salvage value, it is 5,00,000 and it is decreasing every year by 50,000, so next year it will be 4,50,000 that this 4,50,000, then 4,00,000 and this way. Now at which so basically we have to find AEi. Now at suppose n years at n years so that AEi is minimum. So basically we have to find that time when you can say that this machine if used this many years gives you minimum annual equivalent.

Now let us see how to find the annual equivalent value. If we use it for one year the first cost is 10,00,000 - the salvage value during the first year is 5,00,000 A by P I 1, so I is given as rate of interest 15% + 5,00,000 multiplied by .15. This is the capital recovery with return part then you have operating cost. Now let us see that in this series this is a uniform gradient series, so it is better to write the general term in terms of that geometric series.

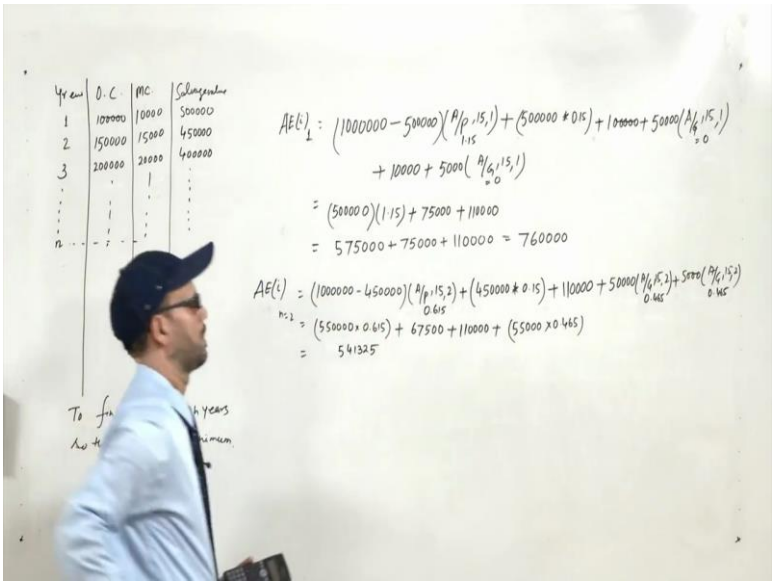
(Refer Slide Time: 19:14)



So this is also a uniform gradient series, the gradient is 50,000 in this case and gradient is 5000 in this case. So we can write 1,00,000 + gradient is 50,000 so this will be multiplied with A by G 15. Similarly you have maintenance cost as 10,000 + 5,000 A by G 15 1. So this is your total annual cost. Now if you find it, we have to refer to the interest table of 15%. A by P 15 1, so A by P 15 1 is 1.15, so it will be 1.15.

This will be equal to 0, this will be equal to 0. So basically this is the first year and A by G 15 1 and A will be 0. This is very much clear that in the first year you are only using 1,00,000 as you operating cost and 10,000 as your maintenance cost. So the statement can be written as 5,00,000 multiplied by 1.15 + 75,000 + this is 1,10,000. So if we take this value it becomes as 5,75,000 + 75,000 + 1,10,000 that becomes equal to 7,60,000.

(Refer Slide Time: 14:12)



So this is the annual equivalent value at n equal to 1 because at n equal to 1 your operating cost value is 1,00,000, maintenance cost is 10,00,000 and salvage value is 5,00,000. Now if you are going to use the machine for two years then n becomes 2. In that case the operating cost is the considered for this two years, in the first year it is 1,00,000 and in the second year it is 1,50,000.

In the second year the maintenance cost also increases by 5000, so in the first year 10,000 and second year 15,000. And in the similar way now salvage value which is to be considered will be 4,50,000 instead of 5,00,000 which is taken for n equal to 1.

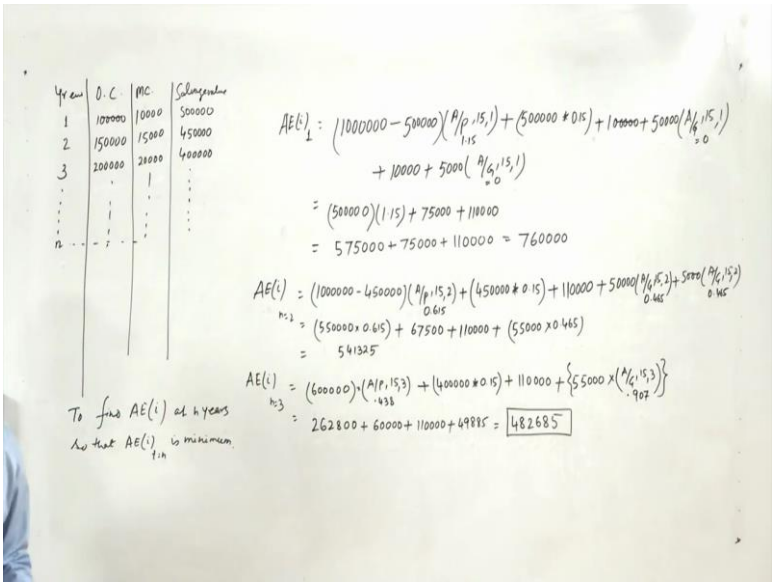
So annual equivalent for n equal to 2 when we take, in that case in this place it will be 4,50,000, so 10,00,000 - 4,50,000 multiplied by now since the machine is going to be used for 2 years, you are going to have the factor A by P 15 2+ salvage value is 4,50,000. It will be multiplied with the interest rate that is .15.

Now we can have the general expression so in this expression these two are the fixed amounts, so we can directly write 110000 + we have 50,000 A by G 15 2 + 5000 A by G 15 2. So if we take the value of the factors A by P 15 2, that becomes .615 and A by G 15 2 is coming as .465. So you have here is 5,50,000 multiplied by .615 + 67,500 + 1,10,000 + 55,000 times .465. Now we will get this value.

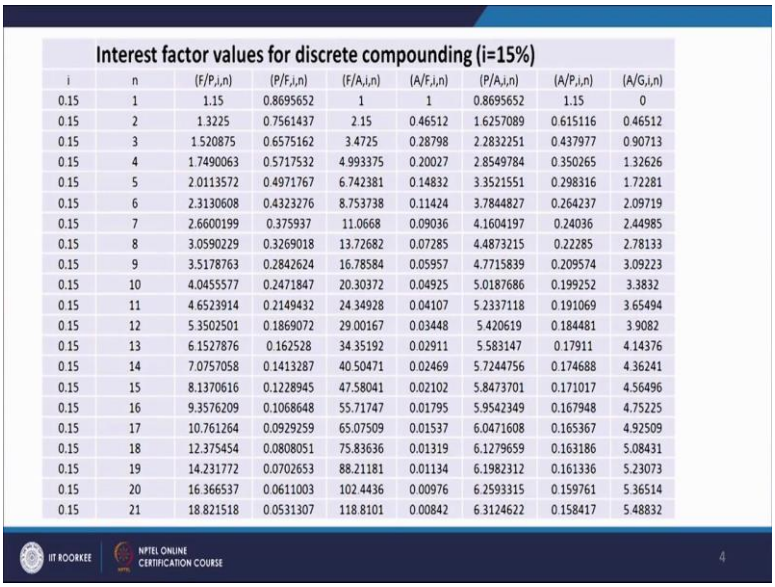
.615 multiplied by 5,50,000 + 67,500 + 1,10,000 + 55,000 multiplied by .465, so it comes out to be 5,41,325. So this amount is less than the amount which has come for n equal to 1 year. It means if the machine is used for 2 years, it is economical as compared to when it is used

for 2 years 1 year. So basically you can economically use it for two years. Now we have to check it for another year and see whether it is economical to use for 3 years.

(Refer Slide Time: 18:04)



(Refer Slide Time: 19:14)



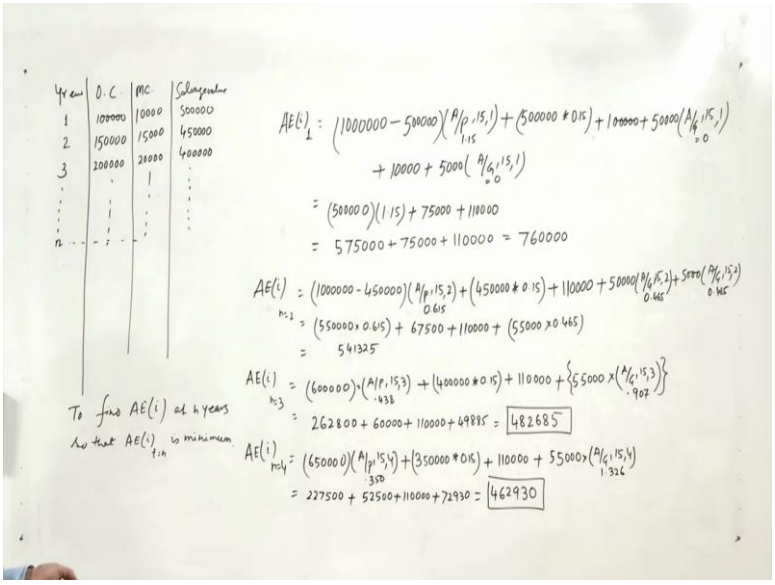
Interest factor values for discrete compounding (i=15%)

i	n	(F/P,i,n)	(P/F,i,n)	(F/A,i,n)	(A/F,i,n)	(P/A,i,n)	(A/P,i,n)	(A/G,i,n)
0.15	1	1.15	0.8695652	1	1	0.8695652	1.15	0
0.15	2	1.3225	0.7561437	2.15	0.46512	1.6257089	0.615116	0.46512
0.15	3	1.520875	0.6575162	3.4725	0.28798	2.2832251	0.437977	0.90713
0.15	4	1.7490063	0.5717532	4.993375	0.20027	2.8549784	0.350265	1.32626
0.15	5	2.0113572	0.4971767	6.742381	0.14832	3.3521551	0.298316	1.72281
0.15	6	2.3130608	0.4323276	8.753738	0.11424	3.7844827	0.264237	2.09719
0.15	7	2.6600199	0.375937	11.0668	0.09036	4.1604197	0.24036	2.44985
0.15	8	3.0590229	0.3269018	13.72682	0.07285	4.4873215	0.22285	2.78133
0.15	9	3.5178763	0.2842624	16.78584	0.05957	4.7715839	0.209574	3.09223
0.15	10	4.0455577	0.2471847	20.30372	0.04925	5.0187686	0.199252	3.3832
0.15	11	4.6523914	0.2149432	24.34928	0.04107	5.2337118	0.191069	3.65494
0.15	12	5.3502501	0.1869072	29.00167	0.03448	5.420619	0.184481	3.9082
0.15	13	6.1527876	0.162528	34.35192	0.02911	5.583147	0.17911	4.14376
0.15	14	7.0757058	0.1413287	40.50471	0.02469	5.7244756	0.174688	4.36241
0.15	15	8.1370616	0.1228945	47.58041	0.02102	5.8473701	0.171017	4.56496
0.15	16	9.3576209	0.1068648	55.71747	0.01795	5.9542349	0.167948	4.75225
0.15	17	10.761264	0.0929259	65.07509	0.01537	6.0471608	0.165367	4.92509
0.15	18	12.375454	0.0808051	75.83636	0.01319	6.1279659	0.163186	5.08431
0.15	19	14.231772	0.0702653	88.21181	0.01134	6.1982312	0.161336	5.23073
0.15	20	16.366537	0.0611003	102.4436	0.00976	6.2593315	0.159761	5.36514
0.15	21	18.821518	0.0531307	118.8101	0.00842	6.3124622	0.158417	5.48832

So once you use for 3 years, so once it goes for 3 years, the salvage value goes down to 4,00,000. So we can directly use so 10,00,000 - 4,00,000 so it will be 6,00,000 multiplied by now A by P 15 3 + here it will be now 4,00,000 multiplied by .15 + 1,10,000 + 55,000 multiplied by factor A by G 15 3. So this is the expression which we get when your n equal to 3 years.

Now for this we will have the values, A by P 15 3 and A by P 15 3 to be .438 and A by G 15 3, A by G 15 3 is coming out to be .907. So we can further write 6,00,000 multiplied by .438 + 60,000 + 1,10,000 + 55,000 multiplied by .907. So we have to further do it separately. 2,62,800 + 60,000 + 1,10,000 + 49,885, so it is coming out to be 4,82,685.

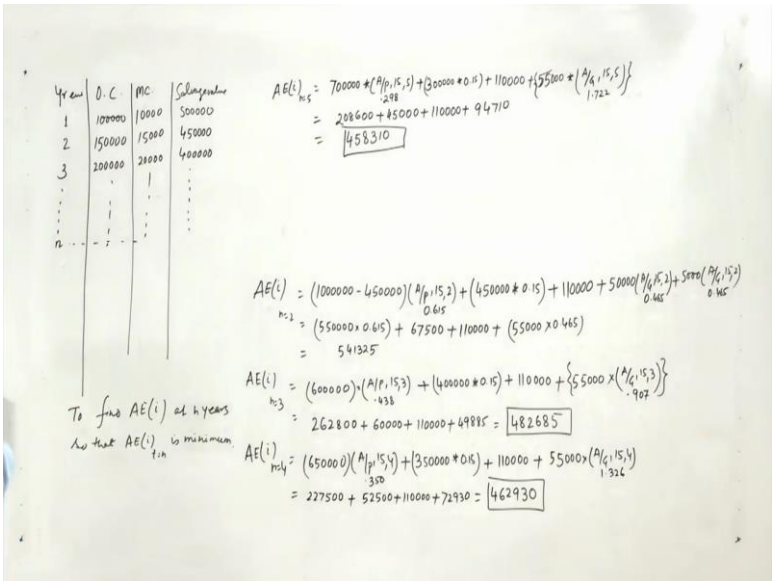
(Refer Slide Time: 20:15)



Now what we see is that if the equipment is used for 3 years the annual equal cost further reduces and it comes down to 4,82,685. Let us see this decreasing trend goes how long. So if you go for 4 years, so this will be now in the fourth year, in the fourth year this will be 3,50,000 so this will be 6,50,000 multiplied by A by P 15 4 and your salvage value is 3,15,000 50,000.

So it will be multiplied with the interest rate .15 + 1,10,000 + 55,000 multiplied by the factor A by G 15 4. So A by P 15 4, A by P 15 4 comes out to be .350 and A by G 15 4 is 1.326. So 2,27,500 + 52,500 + 1,10,000 + 72,930 so this comes out to be 4,62,930. What you see is that this amount is further decreased. If the machine is used for n equal to 4 the amount of annual expenditure which is further reduced to 462930.

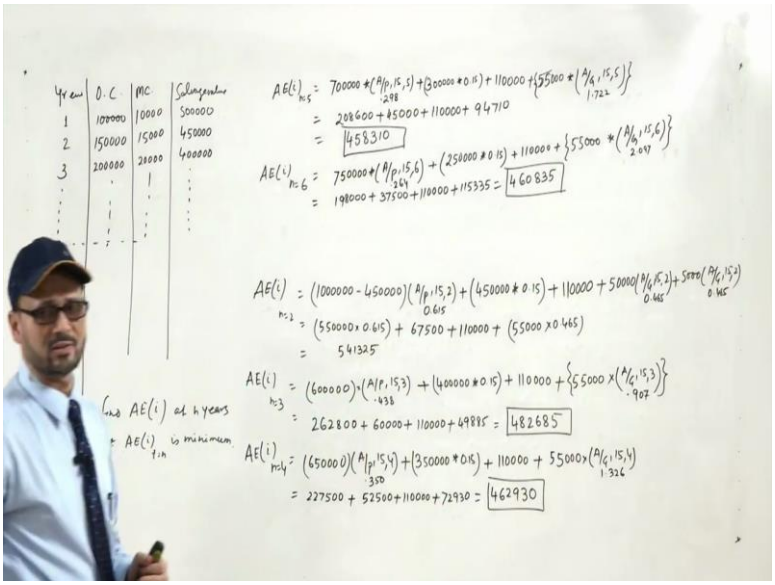
(Refer Slide Time: 23:10)



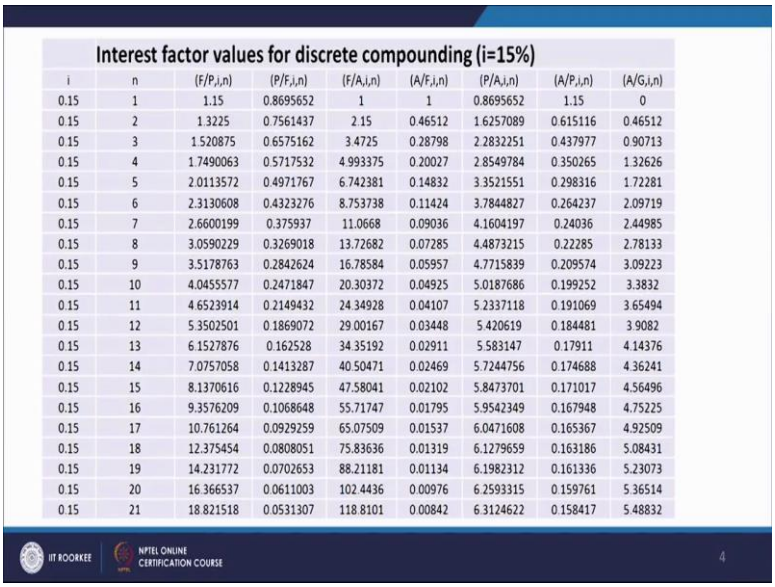
So it is economical to use it for 4 years instead of 3 years but this is not the end, we have to again check for 5 years. So for 5 years for 5 years it will be 3,00,000, so you will have 7,00,000 multiplied by A by P 15 5 + salvage value is 3,00,000, so 3,00,000 multiplied by interest rate + 1,10,000 + 55 thow 5000 multiplied by A by G 15 5. So now A by P 15 5 and A by G 15 5, A by P 15 5 is coming out to be .298 and A by G 15 5 is coming out to be 1.722.

So we have to further use the calculator to get the values. 7,00,000 multiplied by .298 so it is 2,08,600 + 45,000 + 1,10,000 + 1.722 multiplied by 55,000 that is 94,710. This will be equal to 4,58,310. So still it is has further decreased. So even if you use for 5 years, it's still economical. So let us again try for n equal to 6 years.

(Refer Slide Time: 25:45)



(Refer Slide Time: 24:23)



Interest factor values for discrete compounding (i=15%)

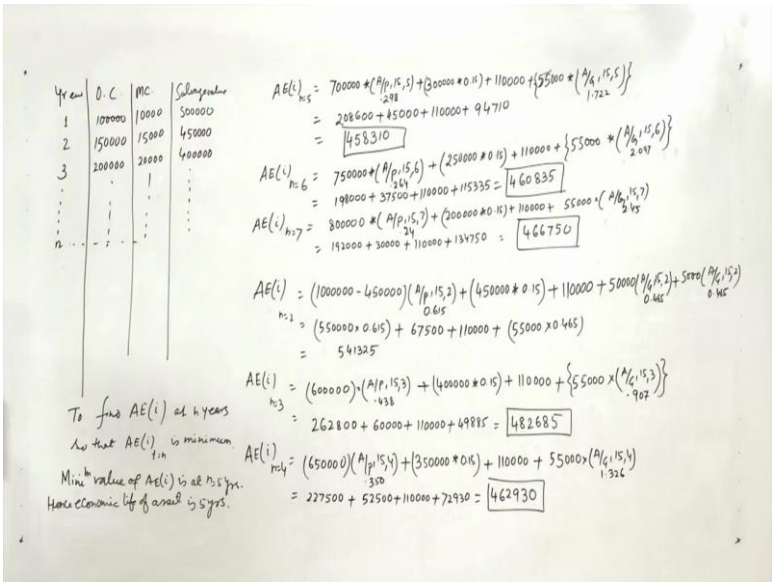
i	n	(F/P,i,n)	(P/F,i,n)	(F/A,i,n)	(A/F,i,n)	(P/A,i,n)	(A/P,i,n)	(A/G,i,n)
0.15	1	1.15	0.8695652	1	1	0.8695652	1.15	0
0.15	2	1.3225	0.7561437	2.15	0.46512	1.6257089	0.615116	0.46512
0.15	3	1.520875	0.6575162	3.4725	0.28798	2.2832251	0.437977	0.90713
0.15	4	1.7490063	0.5717532	4.993375	0.20027	2.8549784	0.350265	1.32626
0.15	5	2.0113572	0.4971767	6.742381	0.14832	3.3521551	0.298316	1.72281
0.15	6	2.3130608	0.4323276	8.753738	0.11424	3.7844827	0.264237	2.09719
0.15	7	2.6600199	0.375937	11.0668	0.09036	4.1604197	0.24036	2.44985
0.15	8	3.0590229	0.3269018	13.72682	0.07285	4.4873215	0.22285	2.78133
0.15	9	3.5178763	0.2842624	16.78584	0.05957	4.7715839	0.209574	3.09223
0.15	10	4.0455577	0.2471847	20.30372	0.04925	5.0187686	0.199252	3.3832
0.15	11	4.6523914	0.2149432	24.34928	0.04107	5.2337118	0.191069	3.65494
0.15	12	5.3502501	0.1869072	29.00167	0.03448	5.420619	0.184481	3.9082
0.15	13	6.1527876	0.162528	34.35192	0.02911	5.583147	0.17911	4.14376
0.15	14	7.0757058	0.1413287	40.50471	0.02469	5.7244756	0.174688	4.36241
0.15	15	8.1370616	0.1228945	47.58041	0.02102	5.8473701	0.171017	4.56496
0.15	16	9.3576209	0.1068648	55.71747	0.01795	5.9542349	0.167948	4.75225
0.15	17	10.761264	0.0929259	65.07509	0.01537	6.0471608	0.165367	4.92509
0.15	18	12.375454	0.0808051	75.83636	0.01319	6.1279659	0.163186	5.08431
0.15	19	14.231772	0.0702653	88.21181	0.01134	6.1982312	0.161336	5.23073
0.15	20	16.366537	0.0611003	102.4436	0.00976	6.2593315	0.159761	5.36514
0.15	21	18.821518	0.0531307	118.8101	0.00842	6.3124622	0.158417	5.48832

In the n equal to 6 years, this amount will further increase by 50,000, so this will be 7,50,000 multiplied by A by P 15 6 + this amount will further decrease so this will be 2,50,000 multiplied by .15 + 1,10,000 + 55,000 multiplied by factor A by G 15 6. Now A by P 15 6 is .264 and A by G 15 6 is 2.097. So we will further use 7,50,000 multiplied by .264 that is 1,98,000 + 37,500 + 1,10,000 + 2.097 multiplied by 55,000, so 1,15,335.

So this comes out to be 4,60,835. Now what we see is that once you use the equipment for 5 years to 6 years the annual equivalent value is seen to increase by about 2500. It means it is economical to use the equipment only for 6 years and 6 so 5 I mean only for up to 5 years. So

5 years is the economical life. Now let us check for one more year, for 7 years we will see further that it will increase.

(Refer Slide Time: 28:36)



So for 7 years it will be 8,00,000 multiplied by A by P 15 7 + 2,00,000 multiplied by .15 + 1,10,000 + 55,000 multiplied by A by P A by G sorry 15 7. A by P 15 7 is coming out to be .24 and A by G 15 7 is 2.45. So if you look at that it will be 1,92,000 + 30,000 + 1,10,000 + 2.45 times 55,000 1,34,750. It comes out to be 4,66,750.

So what we see is that the minimum value of annual equivalent is found at n equal to 5 years and that is why this life of 5 year is said to be so minimum value of AEi is at n equal to 5 years, hence economical life of the asset is 5 years. So this is how we calculate the economical life of the asset. We can solve different problems based on that and you can have the confidence build up and so on. Thank you.