Engineering Economic Analysis
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Lecture 18
Replacement Because of Improved Efficiency, Inadequacy, Demand etc.

Welcome to the lecture on replacement analysis. So in this lecture we will deal with some situations where replacement is because of inadequacy or because of obsolescence. So we have earlier studied that because of these reasons like inadequacy or obsolescence the replacement is suggested. And economic terms, you have to evaluate the proposals annual equivalent or present worth or the future worth and then you have to come.

Now in this case of inadequacy as the name suggests that the company is not able to meet the demand which is now with the company. It has a unit which is having less capacity and it needs to install one more unit so that it supplements the existing unit or it has replace this just to dispose this present asset and take a new asset.

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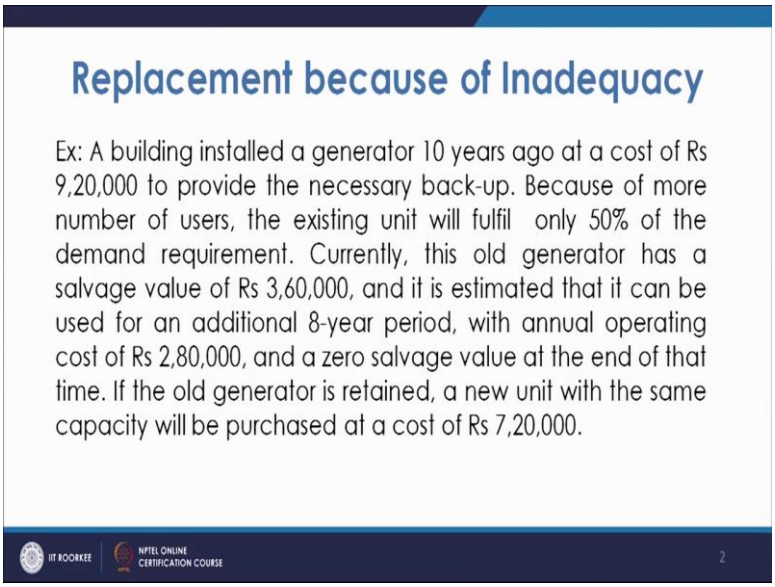

So the problem is that a building installed a generator 10 years ago at a cost of Rs. 920,000 to provide the necessary backup. It had purchased this generator 10 years ago, now since there are more number of users it is only able to fulfill 50% of the demand, so it needs the similar rating of generator.

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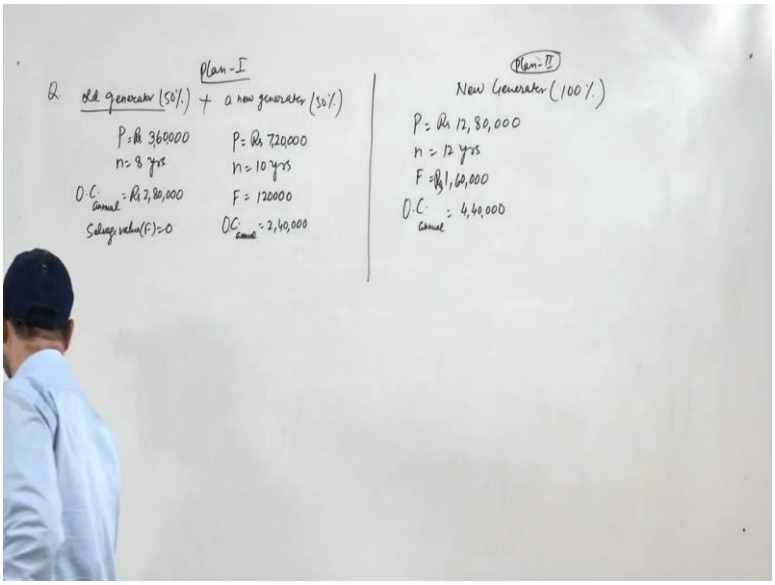

The old generator has a salvage value of 3,60,000 and it is estimated that it can be used for additional 8 year period with annual operating cost of 2,80,000 and a zero salvage value at the end of that time. So it means if we try to solve this problem what we have is, we have old generator. It was purchased in 9,20,000 so it is gone cost, it is a sunk cost, now its value is 3,60,000. So its present cost is 3,60,000, life is 8 years and annual operating cost is 2,80,000.

Salvage value at the end of the life is zero. Now if the old generator is retained, a new unit with the same capacity will be purchased at a cost of Rs. 720,000. So basically you have to have a new generator because it is meeting 50% of the demand, so this will meet 50% of demand. So if the decision is to keep this unit, you need a similar unit which should satisfy the 50% of the demand and this can be purchased at Rs. 720,000.

So for this P is 7,20,000, service life is 10 years, salvage value is 1,20,000 and operating cost annually is 2,40,000. So this is the one option, the first option is that you retain this old generator and take a new generator which will also supply 50% and your demand will be met. Second option is that you buy a new generator having the capacity of two small units combined, so it will give you 100% demand fulfilled.

It has initial cost of 12,80,000, new unit which has 100% capacity to fulfill the demand. It has P as 12,80,000, life is 12 years, its salvage value is 1,60,000 at the end of 12 years and operating cost annually is 4,40,000. Now we have to suggest whether we should keep this generator and have a generator of half the capacity or we should replace this and take the new

generator. So it is suggested that the MARR is 15%, and study period should be taken as 8 years.

So study period taking 8 years means, it is assumed that after 8 years you will have **cer** certain value to it that is implied salvage value, this also had that and in that case the annual equivalent basis of comparison looks to be okay. So we will proceed with finding the annual equivalent value and the option with lower amount of annual equivalent will be suggested or will be preferred. So this is our plan 1 and this is our plan 2.

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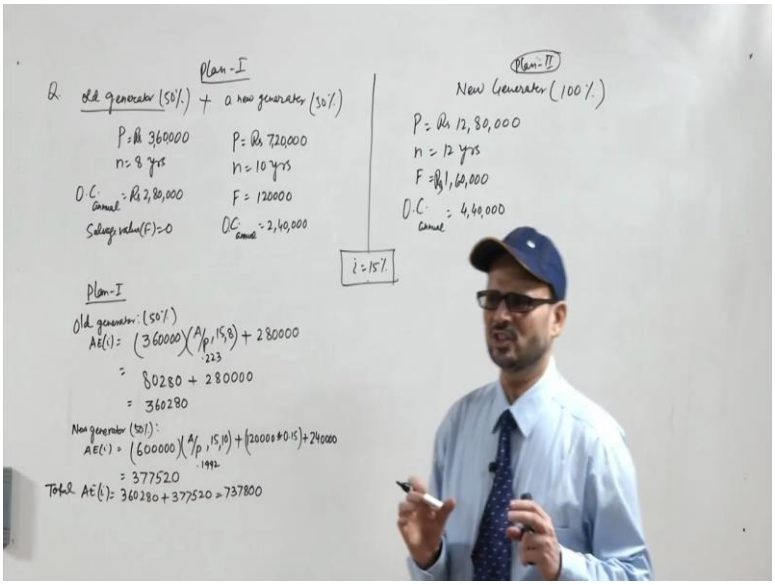

Now in the plan 1, if we find the annual equivalent value for this, plan 1 for old generator. The annual equivalent will be P minus F, so salvage value zero so 3,60,000 into A by P i n, n is 8, so A by P and interest rate is taken as 15%. In both the cases I is taken as 15%, this is the minimum attractive rate of return. So it will be 15 8 plus you have F into I, so that concept part is gone because F is 0.

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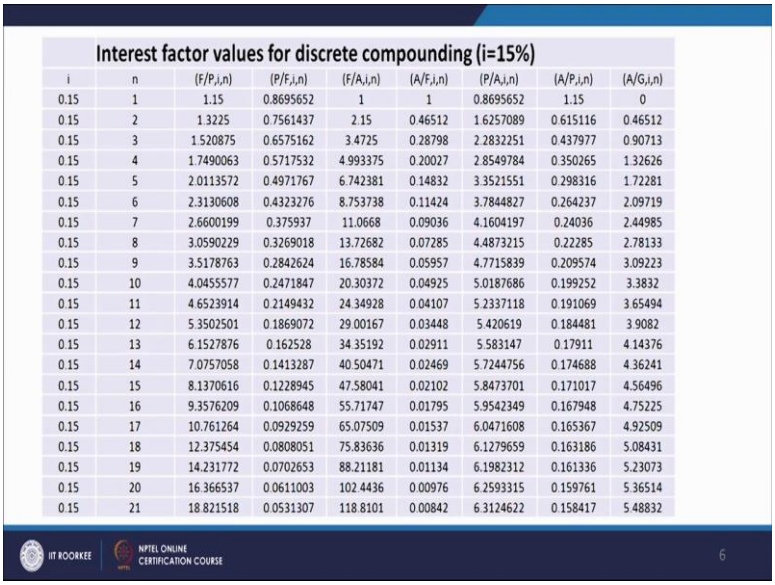

Interest factor values for discrete compounding (i=15%)

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

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So this is the capital recovery with return part then you have annual operating cost that is 2,80,000. So A by Pip 15 8 we can get from this table, A by P 15 8 will be .223, so this will be .223. In that case we will multiply this 80280 plus 280000 that is 360280.

Then now this is for the old generator which is giving 50% and in the plan 1, the new generator which is giving another 50%, for that annual equivalent will be you have P as 7,20,000, F as 1,20,000, so P minus F that is 6,00,000 multiplied by A by P i n, n is 10 here so it will be A by P 15 10 plus F into I, so this is F is 1,20,000 into I rate is .15 and plus the operating cost annually is 2,40,000.

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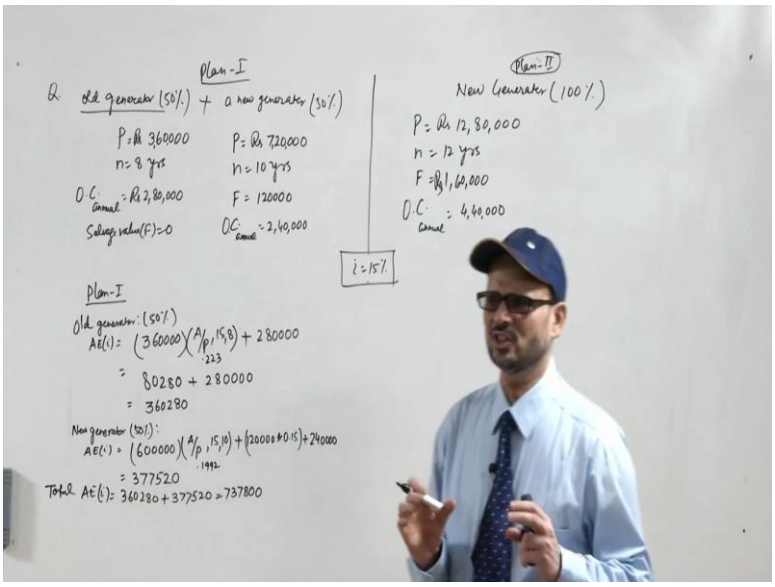

A by P 15 10 which is coming out to be .199, so it will be .1992, so once we get the values, 6,00,000 multiplied by .1992 plus 18,000 plus 2,40,000 this comes out to be 377520. So this is the annual equivalent for the old generator which will be giving 50% of the demand requirement which will be fulfilling, now new generator fulfilling the 50% requirement is 3,77,520. So total annual value will be 360280 plus 377520 and if we add that it will be 737800.

This is the annual expenditure using 8 year study period for the option in which we try to retain the old generator. Now if we find the annual equivalent for the new generator, that is plan 2 is basically you are taking a new generator giving you 100% the demand requirement fulfilled. It would be 12,80,000 minus 1,60,000 so it will be 11,20,000. P minus F multiplied by A by P I n, so 15 I and n is here 12 years plus F into I, so 1,60,000 into .15 plus annual operating cost that is 4,40,000.

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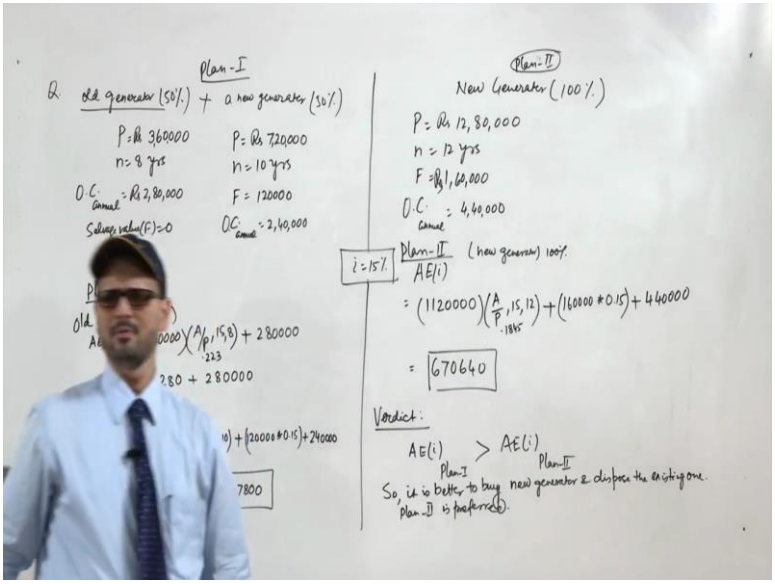

A by P 15 12 and for 12 it is .1845. So if we compute the values, it will be 11,20,000 multiplied by .1845 plus 24,000 plus 4,40,000, it comes out to be 6,70,640. Now what we see is, in plan 1, we get the annual equivalent value as 7,37,800 and in the plan 2 we are getting 6,70,640. So since the, so verdict is AEi for plan 1 is greater than AEi for plan 2 and this is about the cost incurred so it is better to buy new generator and dispose the existing one. Plan 2 is preffered.

So this is how when we have the question regarding the problem where there is inadequacy and you are to decide whether to replace or not, we can deal with the problem in such

manner. We will deal with the next problem, this problem is replacement because of the obsolescence.

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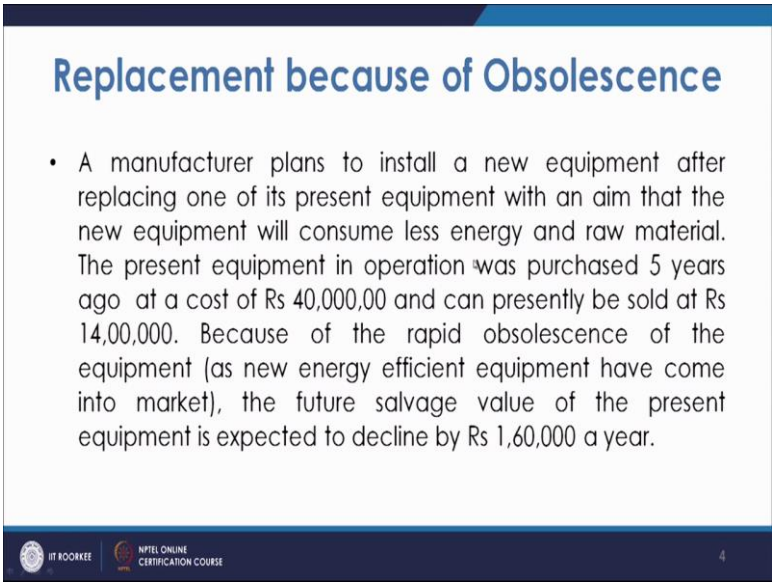

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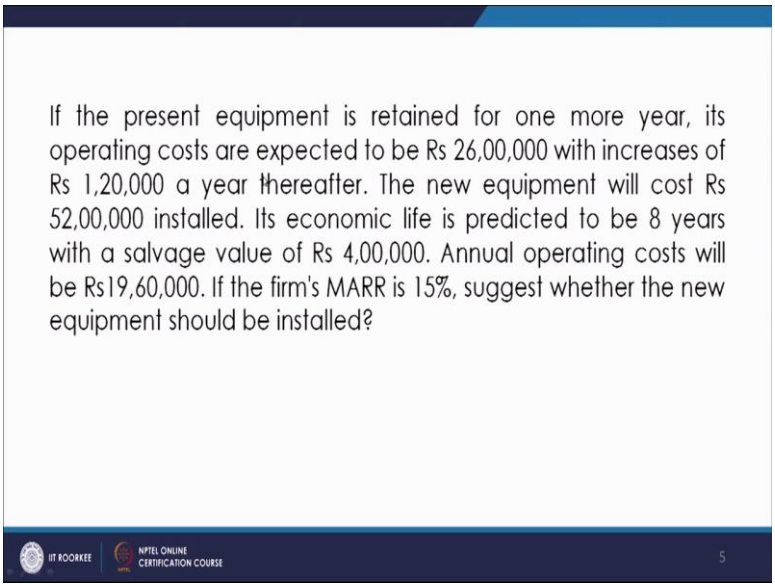

This problem says that the manufacturer plans to install a new equipment after replacing one of its present equipment with an aim that the new equipment will consume less energy and material. So basically the existing equipment has become obsolete, it is consuming more energy and the new equipment which is proposed, it will consume less energy and raw material.

The present equipment in operation was purchased 5 years ago at a cost of Rs. 4,000,000 and can presently be sold at Rs. 1,400,000. So it means present machines cost is 14,00,000. Because of the rapid obsolescence of the equipment because of the arrival of new energy efficient equipment the future salvage value of present equipment is expected to decline by Rs. 160,000 a year. So basically it salvage value will decline every year.

If the present equipment is retained for one more year its operating cost is expected to be Rs. 2,600,000 with increases of Rs. 120,000 a year thereafter. So operating cost is going to increase every year from 26,00,000 by every year by Rs. 1,20,000. New equipment will cost Rs. 5,200,000 installed. Economic life is 8 years with salvage value of 4,00,000 after 8 years. Annual operating cost is Rs. 1,960,000.

So at 15% MARR we have to suggest whether replacement is suggested or not. So let us all this problem. So what we have is, we have plan 1 and plan 2.

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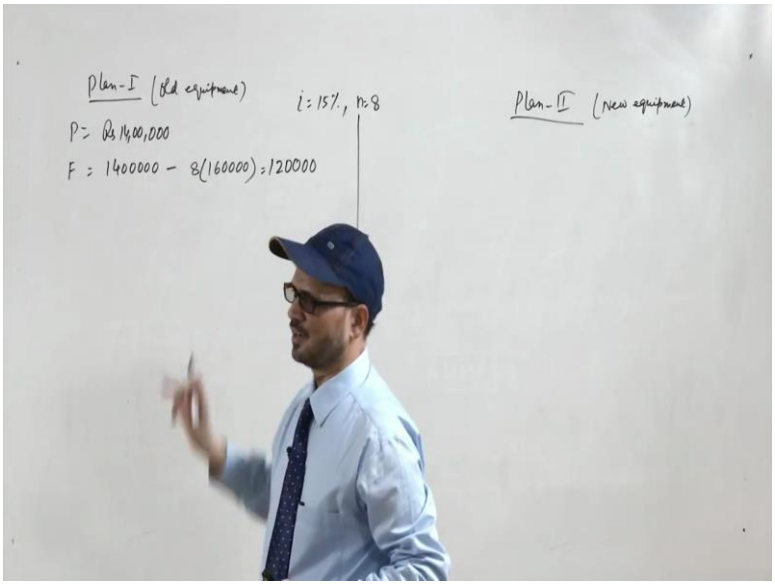

In plan 1 we have the old machine and here you have new equipment. So old equipment and new equipment. Now in this case it is said that your MARR is 15%, so the common data is I is 15%. Study period for the new machine is 8 years and for the old machine, it can be used, so for the equivalent comparison we have 2 go for 8 years of study period so that we can compare their values equivalent values, so we will take n as 8.

Now for the old machine, we have seen that it was purchased in some cost at 40,00,000 which is a sunk cost, so it has nothing to do with this. Its present cost is 14,00,000, so it P is 14,00,000. Now future salvage value of present equipment is expected to decline by Rs.

160,000 a year. So basically if you are using it for 8 years, the future salvage value after 8 years will be 14,00,000 minus 8 times 160000 so it will be 12,80,000 so 1,20,000.

Because we are taking the study period as 8 years, a comparative period for equal for both, so after 8 years the salvage value will be 1,20,000 of this machine. Now it is if it is retained for one more year, its operating cost is 26,00,000 and since it is kept for 7 more years, in the first year it is 26,00,000 but operating cost in the so operating cost basically, it is 26,000 in the first year 26,00,000 in the first year and plus 1,20,000 increase every year.

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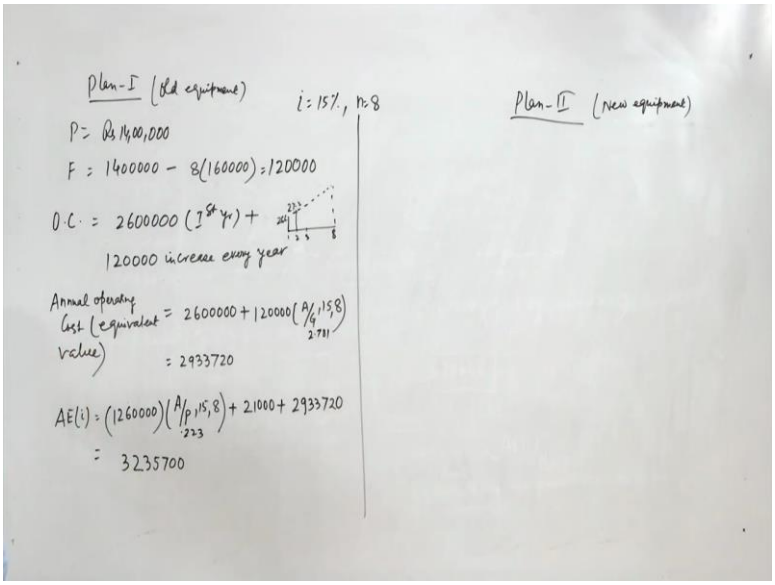

So basically you can have its annual equivalent value, if you try to have the annual value, it will be nothing but so annual operating cost equivalent value it will be nothing but it is a geometric series, it is a basically uniform gradient series, so you have 26,00,000 plus this is the G so 1,20,000 A by G 15 8. Operating cost is basically that way, 26,00,000 is the in this year first year and it is going every year increase by 27 26 plus 1 27.2 and like that.

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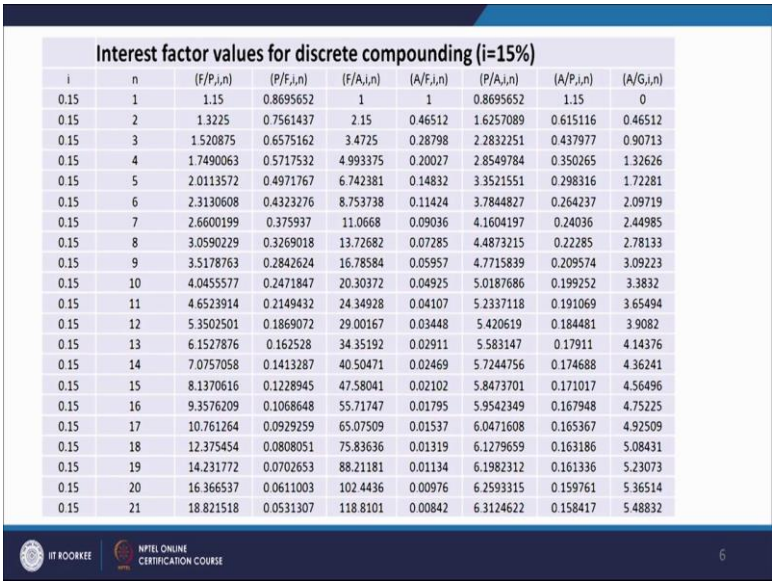

i	n	(F/P,i,n)	(P/F,i,n)	(F/A,i,n)	(A/F,i,n)	(P/A,i,n)	(A/P,i,n)	(A/G,i,n)
0.15	1	1.15	0.8695652	1	1	0.8695652	1.15	0
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0.15	21	18.821518	0.0531307	118.8101	0.00842	6.3124622	0.158417	5.48832

So it is going like this up to eighth year. So that is why we are getting the annual equivalent value of the operating cost as this amount and A by G 15 8 we can get it from the table, A by G 15 8 will be 2.781. So it will be 1,20,000 multiplied by 2.781 plus 26,00,000, it is29,33,720.

Now further if you try to find the annual equivalent value AEi it will be P minus F so 14,00,000 minus 1,40,000 that is 12,60,000 multiplied by A by P 15 8 plus F into I 140000 into .15 so that is 21000 plus annual operating cost that is 29,33,720. So A by P 15 8, it will be .223, so this amount will be plus 21000 plus 2933720, so it comes to be 32,35,700.

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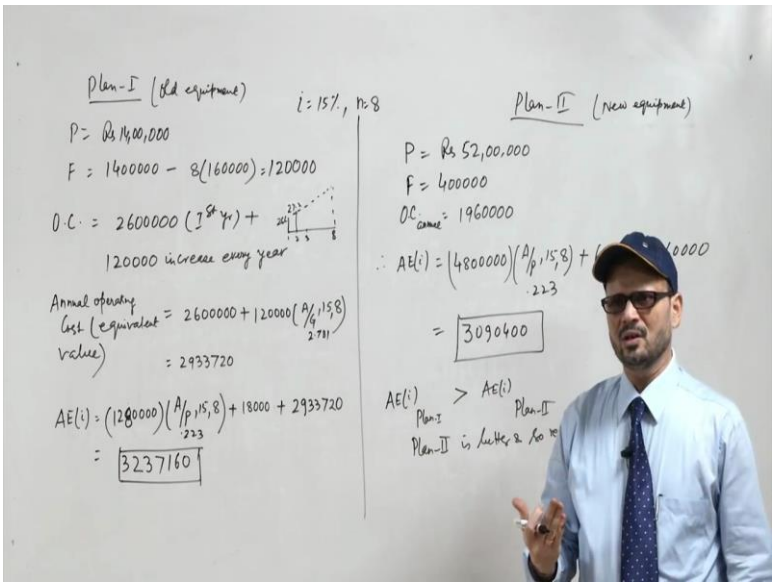

Now if we look at the plan 2 in that case we have P as Rs. 52,00,000 and n is 8 anyway, salvage value is 4,00,000, operating cost is 19,60,000 annual. So annual equivalent value will be P minus F that this 48,00,000 A by P 15 8 plus F into I so it is 60000 plus operating cost annual 19,60,000 so it is .223. So we can get this value also 48,00,000 multiplied by .223 plus 60,000 plus 19,60,000 so it is coming out to be 30,90,400. So what we see is we have 30,90,400.

In fact there has been a mistake here, this 1,20,000 is the F, so P minus F will be 12,80,000. So it will be instead of 12,60,000, it will be 12,80,000 and this will also be 1,20,000 multiplied by .15, so it will be 18,000 so if we add them one 12,80,000 multiplied by .223 plus 18,000 plus 29,33,720, it comes out to be 32,37,160.

So what we see is, the plan 1 gives you the annual equivalent cost as 32,37,160 if we retain the old equipment and if we purchase the new equipment, the annual equivalent cost is 30,90,400. It means going for plan 2 is advantageous, AEi plan 1 is greater than AEi plan 2. Plan 2 is better and so replacement is suggested because it involves the cost to run. This is annual equivalent cost, that is why we will go for the option which gives you minimum cost.

So it is better in this case to change the old equipment and go for the new equipment which is basically based on new technology consuming less energy and that is why the replacement is suggested. So this is how we solve the problems based on inadequacy and because of the obsolescence and so on. So as you practice and practice, you will get more confidence on these questions. Thank you.