Depreciation, Alternate Investment and Profitability Analysis.
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Lecture-9.
**Alternative Investment – Introduction to Alternate Investment and Annual Cost**
Method - I.

Welcome to the course Depreciation, Alternative Investment and Profitability Analysis. Today's lecture we will start the module 2 that is alternative investment and in this alternative investment will take Annual Cost Method. So in this lecture I will introduce to the Alternative Investment and Annual Cost Method. Alternative Comparison or Alternative Investment, the common problems confronted in engineering economics are those where alternative comparison between two or more mutually exclusive alternative investments compete involving different series of capital disbursements.

For example, if one alternative have both less capital investment as well as operating cost there is no need of comparing it with other alternative. However, the comparison becomes essential if one alternative offers higher initial capital investment but lower annual operating cost in the successive years in comparison to the second alternative which offers less capital investment initially but subsequently higher operating cost.

In such cases one has to find trade-off between the future advantages of a lower operating cost vis-a-vis disadvantage of higher initial investment where different series of disbursement are compared, it is necessary to reflect the time value of money under each alternative. A variety of methods exists for selecting the superior alternative from a group of alternative proposals. Each method has its own merits and applications.

The present module demonstrates how to apply the profitability measures to select the best alterative out of a set up mutually exclusive alternatives properly. Mutually exclusive alternatives means that the selection of one alternative excludes the consideration of any other alternative.

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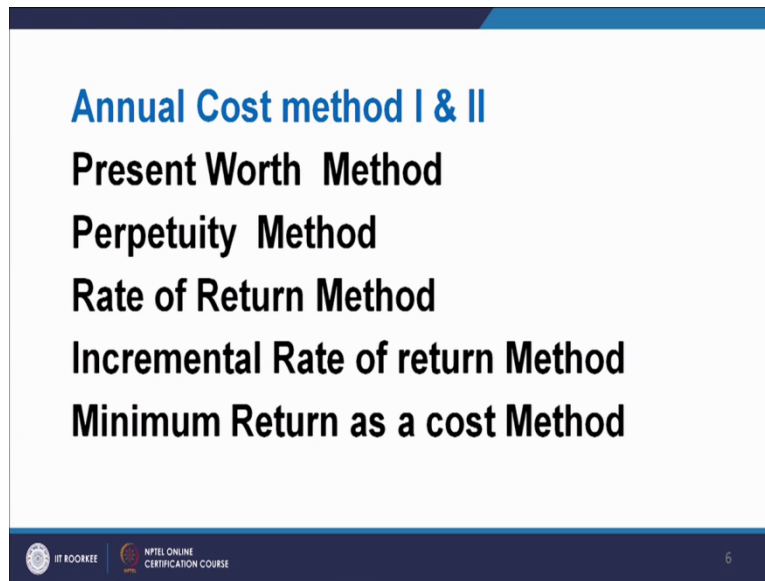
Now in the, these lectures we will cover Annual Cost Method 1 and 2, Present Worth Method, Perpetuity Method, Rate of Return Method, Incremental Rate Of return Method, Minimum Return as a cost Method. So all these methods will study in this course, Annual Cost Method which is the topic of this lecture in engineering economics the annual cost method or equivalent Annual Cost or Annual Worth Method is the cost per year of owing and operating an asset over its entire life span.

This method is often used as a decision making tool in capital budgeting when comparing investment projects of un-equal life spans is required. For example suppose if event A has an useful life of 11 years and that a project B is 15 years it could be inappropriate to simply compare the net present value of both projects unless neither project could be repeated.

The annual cost of owning an asset over its entire life. The Annual cost is calculated based on annuity formula as:

$$\text{Annual cost} = \frac{\text{Present cost of Asset} * \text{rate of interest}}{1 - (1 + \text{rate of interest})^{-\text{useful service life in years}}}$$

$$A = P \frac{i(1+i)^N}{(1+i)^N - 1} \quad \text{Or} \quad A = P \frac{i}{1-(1+i)^{-N}}$$

A = Amount of annuity per year
F = future value of sum of all annuities
P = present value of sum of all annuities
i = interest rate per year
N = no. of years the annuities are paid
No. of payments are equal to no. of compounding years

N payments
N period
Cash flow diagram of Ordinary Annuity

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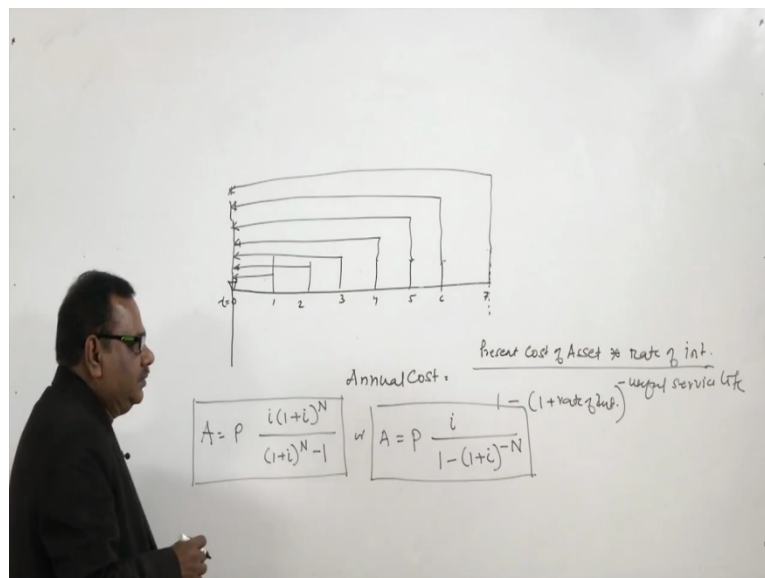
Now let us see how to derive the formula for annual cost method. Now in this slide before you it is given. I am explaining this basically, if I draw a timeline at timeline t is equal to zero, a investment is don,e an investment is done here. Now this is the time when the property retires, so annual cost method converts this depreciable amount into a series of payments whose, when present value is calculated, when all these payments when converted into its present values and add up, then we find that the whatever value I have invested at t is equal to zero equals the summation of all present values.

So annual cost can be calculated with this present cost of asset into rate of interest divided by 1 - 1 + rate of interest to the power - useful service life. So basically this is a annuity so you can use the annuity formula A is equal to p i 1 + i to the power N divided by 1 + i to the

power N - 1 and when this is simplified then we get a formula A is equal to p i 1 - 1 + i to the power - N.

This is the formula or we can use this also as well for calculation of annuity which is an annual cost in the present case. Present value and net present value have a serious flaw when it comes to making comparison between available investments. The flaw lies in the fact that you must set that opportunity rate a fixed rate to be used over the investment life and as we noted that opportunity rate must reflect comparable risk for comparable investments. That means you fix a quantitative calculation based heavily on a quantitative qualitative judgement, in comparing two investments a mistake or inaccuracy in the opportunities cost that is discounted rate, will lead to a distortion of present values.

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	Machine "A"	Machine "B"
Capital investment	Rs.45,000	Rs.30,000
Estimated useful life	10	10
Operating cost(labor, material, maintenance, depreciation, insurance, etc) per year	Rs.8000	Rs.15000
Rate of return	10%	10%
Solution given below		
Annual cost of capital recovery	45000*0.16274539 = Rs.7323.54	30000*0.16274539 = Rs.4882.36
Total annual cost(annual cost of capital recovery + annual operating cost)	Rs.15323.54	Rs.19882.36

Decision: One should purchase Machine "A" in comparison to Machine "B" as its total annual cost is low

Now we take an example now the objective of this example is given the capital investment zero salvage value attractive rate of return, equal estimated life and different annual operating cost. Compare two different investments based on annual cost method. So in the example no 1, the data for two machines are given. Select the appropriate machine based on annual cost method. So machine A, machine B, capital investment this is 45,000, this is 30,000, useful life N is 10 years 10 years, operating cost is equal to rupees 8,000 per year and this is rupees 15,000 per year and i is 10 percent and 10 percent and our aim is to find out using annual cost method that which machine I should select.

Now the annual cost of a the capital recovery is the annuity based on time value of money that one has to pay throughout the useful life of the machine which will be equal to the capital cost of the machine at the start of the first year that I had already told you. So annual cost of capital recovery, annual cost of capital recovery is equal to capital investment into i 1 - 1 + i to the power - N this is the value. So for A if I calculate this then it is equal to for A the annual capital recovery is equal to 45,000 into 0.1 divided by 1 - 1 + 0.1 - 10 to the power - 10 which comes out to be rupees 7323.54.

Similarly for B if I calculate the annul capital recovery factor, then this is 30,000 into 0.1 divided by 1 - 1.0.1 - 10 is equal to rupees 4882.36 and this is per year and this is per year. So if I keep this value here 7323.54 and 4882.36 so what basically I have done, that I have converted this capital cost whose life span is 10 years into a per year cost. Now, so annual cost will be basically the addition of this and this. If I add these two this becomes rupees 5323.54 and if i add this and this then it becomes rupees 19,882.36.

So what we find that machine A is cheaper because its cost is 15,343.54 whereas the cost of the machine B is 19,8082.36 and hence our selection will be machine A, so we will go for machine A. This selection we have made based on annual cost method.

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Table below shows the Present worth of each payment from end of 1st year to end of 10th year for machine "A" and the total of present worth values is Rs.44999.98 ≈ Rs.45000.

Instalment	Year ending	Instalment amount ,Rs.	Present worth of the instalments, Rs.
1st	01	7323.54	6657.764
2nd	2	7323.54	6052.512
3rd.	3	7323.54	5502.284
4th	4	7323.54	5002.076
5th	5	7323.54	4547.342
6th	6	7323.54	4133.947
7th	7	7323.54	3758.134
8th	8	7323.54	3416.485
9th	9	7323.54	3105.896
10th	10	7323.54	2823.542
Total at the start of the 1st year			44999.98

Now this is a table I had given to show that if the present value of all the instalments are calculated comes out to be the original cost of the equipment at t equal time equal to zero that is for A machine it is 45,000 and for B machine it is 30,000. I have calculated for A machine only, so it is 45,000. Now let us take the second problem there is data of two machines A and B are given below.

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Example-2: Data for two machines A & B are given below. Plot how the net present worth for both machines A & B vary with variation in minimum acceptable rate of return(MARR) from 6% to 30%

	Machine "A"	Machine"B"
Capital investment ,Rs.	Rs.10,000	Rs.8,000
Estimated useful life, year	10	10
Salvage value, Rs.	0	0
Operating cost(labor, material, maintenance, depreciation, insurance, etc) Rs. per year	Rs.3000	Rs.3500
Rate of return	15%	15%

Example - 2

	Machine 'A'	Machine 'B'
Cap. Investment	10,000	8,000
N	10	10
Salvage Value	0	0
Operating cost/yr.	3,000	3500
i	+16%	15%
Annual cost of Capital recovery	1992.52	
	Rs 4992.52	

Annual Cost of Capital recovery "A"

$$= 10,000\left[\frac{0.15}{1-(1+0.15)^{-10}}\right]$$

$= Rs\ 1992.52\ /yr$

Total annual cost $= Rs\ 1992.52 + 3000$

$= Rs\ 4\ 992.52$

Example - 2

	Machine 'A'	Machine 'B'
Cap. Investment	10,000	8,000
N	10	10
Salvage Value	0	0
Operating cost/yr.	3,000	3500
i	+16%	+15%
Annual cost of Capital recovery	1992.52	1594.02
	Rs 4992.52	Rs 5094.02

Annual Cost of Capital recovery "B"

$$= 8,000\left[\frac{0.15}{1-(1+0.15)^{-10}}\right]$$

$= Rs\ 1594.02$

Total annual cost $= 1594.02 + 3500$

$= Rs\ 5094.02$

Data for two machines A and B are given below. Plot how the net present worth or for both machines A and B vary with variation in minimum acceptable rate of return from 6 percent to 30 percent. Now here I have again two machines now the capital investment is 10,000 here, here 8,000, now useful life is 10, 10, here savage value 0, 0, here operating cost is 3,000 and here 3,500. Now rate of return is 15 percent, here 15 percent, now you have to select machine or A or machine B based on the annual cost method.

So basically this cost is per year and this cost is for 10 years, so I have to convert this cost into per year cost using annual cost method and then I can add this with this to find out the total annual cost and based on the annual cost I will take a decision. Then let us see now annual of capital recovery for A is equal to 10,000 into 0.15 the value of i 1 - 1 + 0.15 to the power - 10. Now this comes out to be rupees 1992.52 and this unit is per year.

So the total annual cost that means per annum how much I am spending is equal to rupees 1992.52 + this operating cost which is per year basis 3,000, it comes out to be rupees 4992.52. So this is N1 cost of capital recovery is 1992.52 and while I add this with this, this becomes rupees 4992.52. Similarly capital recovery for machine B would be 8,000 and this come out to be 1594.02 so this is 1594.02 + 3,500 and this comes out to be rupees 5094.02.

So this is 1594.02 and we add this becomes rupees 5094.02, this + this. So as the annual cost of the machine A is less than machine B so my selection will be A based on annual cost method. So summarizing the lecture, in this lecture I have introduced the concept of alternative investment and one of the methods for achieving the alternative investment which was annual cost method has been introduced, but some part of annual cost method has been introduced in the lecture number 2 of this series that is module 2 will see more problems on annual cost method. Thank you.