CH2404 Process Economics

Unit – III

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Profitability Estimates

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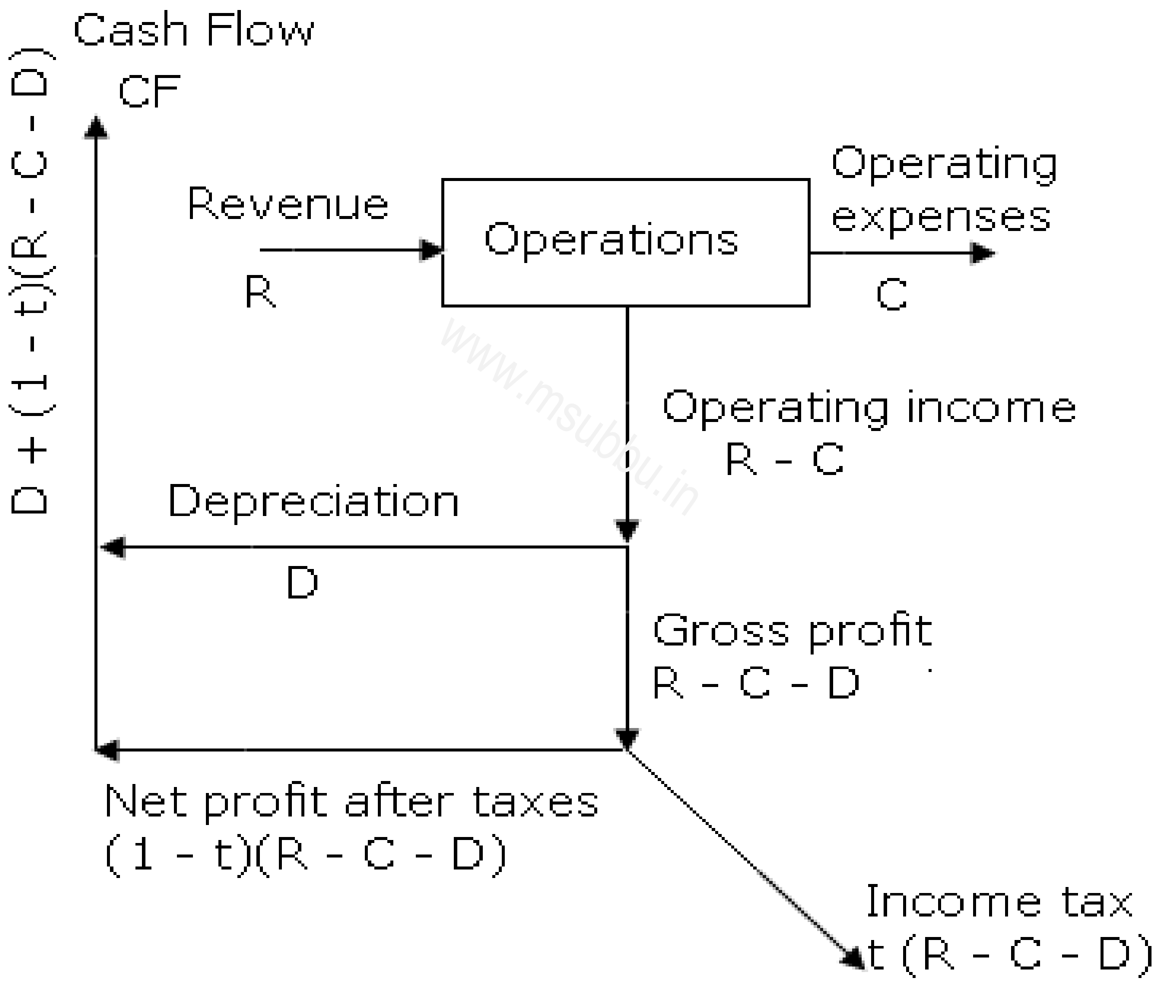
Cash Flow

Cash flow is the movement of cash into or out of a business, project, or financial product. It is usually measured during a specified, finite period of time.



Cash Flow - Example

Sales	$30,000
Cost of goods	(10,000)
Gross profits	$20,000
Depreciation	(10,000)
Pre-tax income	$10,000
Taxes (40%)	(4,000)
Net income after tax	$6,000
Cash flow = NI + deprec	$16,000

Methods for Profitability Evaluation

- Total profit alone cannot be used as the deciding profitability factor in determining if an investment should be made. The most commonly used methods for profitability evaluation are:
  - Rate of return on investment
  - Net present worth
  - Discounted cash flow based on full-life performance
  - Payout period
  - Capitalized costs

- Each of these methods has its advantages and disadvantages. Because no single method is best for all situations, the engineer should understand the basic ideas involved in each method and be able to choose the one best suited to the needs of the particular situation.

Rate of Return on Investment

$$\text{ROI} = \frac{\text{annual net profit (earnings) after taxes}}{\text{total capital investment}} \times 100$$

- *The yearly profit divided by the total initial investment* necessary represents the fractional return, and this fraction times 100 is the standard percent return on investment.

- To determine the profit, estimates must be made of direct production costs, fixed charges including depreciation, plant overhead costs, and general expenses. Profits may be expressed on a before-tax or after-tax basis, but the conditions should be indicated.

- Both working capital and fixed capital should be considered in determining the total investment.

Disadvantages of ROI method

Although this method is simple to use and relates to accepted accounting methods, it has some serious disadvantages:

- The time value of money is ignored.
- A basic assumption in this method is that all projects are similar in nature to each other.
- It does not consider timing of cash flows.
- It does not consider capital recovery.

Payout Period (POP) or Payback Period

- ***Payout*** period, or ***payout time,*** is defined as the minimum length of time theoretically necessary to recover the original capital investment in the form of cash flow to the project based on total income minus all costs except depreciation.

- Generally, for this method, original capital investment means only the original, depreciable, fixed-capital investment, and interest effects are neglected.

$$\text{Payout period (POP)} = \frac{\text{depreciable fixed capital investment}}{\text{after-tax cash flow}}$$

Pay Back Period - Example

The heat pump costs $10,000 initially. The heat pump saves $2,500 per year in energy costs for 20 years. The maintenance costs are $500 per year for 20 years. The estimated salvage value is $500 at the end of 20 years.

End of Year (EOY)	Cash Flow
0	–$10,000
1-19	$2,500 – $500 = $2,000
20	$2,500 – $500 + $500 = $2,500

The heat pump discussed above has an initial cost of $10,000, an energy savings of $2,500 per year, and a maintenance cost of $500 per year. Thus, the net annual savings is $2,000. Therefore, its *Payback period* would be ($10,000)/($2,000/yr) = 5 years.

Pay Back Period

- The advantage of the *Payback period* is its simplicity, and it is easily understood by workers and management. It does provide a rough measure of the worth of a project.

- The primary disadvantages are:
  1) the methodology does not consider the time value of money; and 2) the methodology does not consider any of the costs or benefits of the investment following the payback period.

- No specific lifetime estimate of the project is required, but it is assumed that the lifetime is longer than the *Payback period*. These limitations mean the *Payback period* method tends to favor shorter-lived projects, a bias that is often economically unjustified.

Net Present Worth or Net Present Value

Net present worth (NPW) = present worth of all cash inflow − present worth of all investment items

- If the net present worth is positive, the project will earn more than the interest (discount) rate used in the calculations. If the NPW is negative, then the project earns less than that rate.
- When this method is applied to two or more alternative cases, the project with the higher NPW will produce a greater future worth to a company and, therefore, is preferred. Caution must be exercised that projects to be compared have equal lives or that lives can be adjusted to a common time base.

Net Present Worth (or Net Present Value)

Interest rate = 12%

	Projects				
Year	1	2	3	4	5
0	−$70	−$80	−$100	−$150	−$200
1	30	30	40	50	90
2	40	35	50	55	80
3	50	55	60	60	80
4	55	60	65	90	110
NPV	**$59.2**	**$52.0**	**$59.6**	**$38.4**	**$71.0**

$$NPV = -70 + 30/(1+0.12) + 40/(1+0.12)^2 + 50/(1+0.12)^3 + 55/(1+0.12)^4$$
$$= -70 + 26.79 + 31.89 + 35.59 + 34.95$$
$$= \$\,59.22$$

For a project having a life of ten years the following cash flow pattern is expected,

End of years	Net cash flow (Rs.)
0	-50,00,000
1 – 10	20,00,000
10	-1,50,00,000

If the expected interest rate is 20 percent, what is your recommendation about implementing the project? **GATE-1990**

NPV = -50,00,000 + 20,00,000/(1 + 0.2) + 20,00,000/$(1 + 0.2)^2$ + 20,00,000/$(1 + 0.2)^3$ + 20,00,000/$(1 + 0.2)^4$ + 20,00,000/$(1 + 0.2)^5$ + 20,00,000/$(1 + 0.2)^6$ + 20,00,000/$(1 + 0.2)^7$ + 20,00,000/$(1 + 0.2)^8$ + 20,00,000/$(1 + 0.2)^9$ + 20,00,000/$(1 + 0.2)^{10}$ – 150,00,000/$(1 + 0.2)^{10}$

= Rs. 9,62,360

Internal Rate of Return

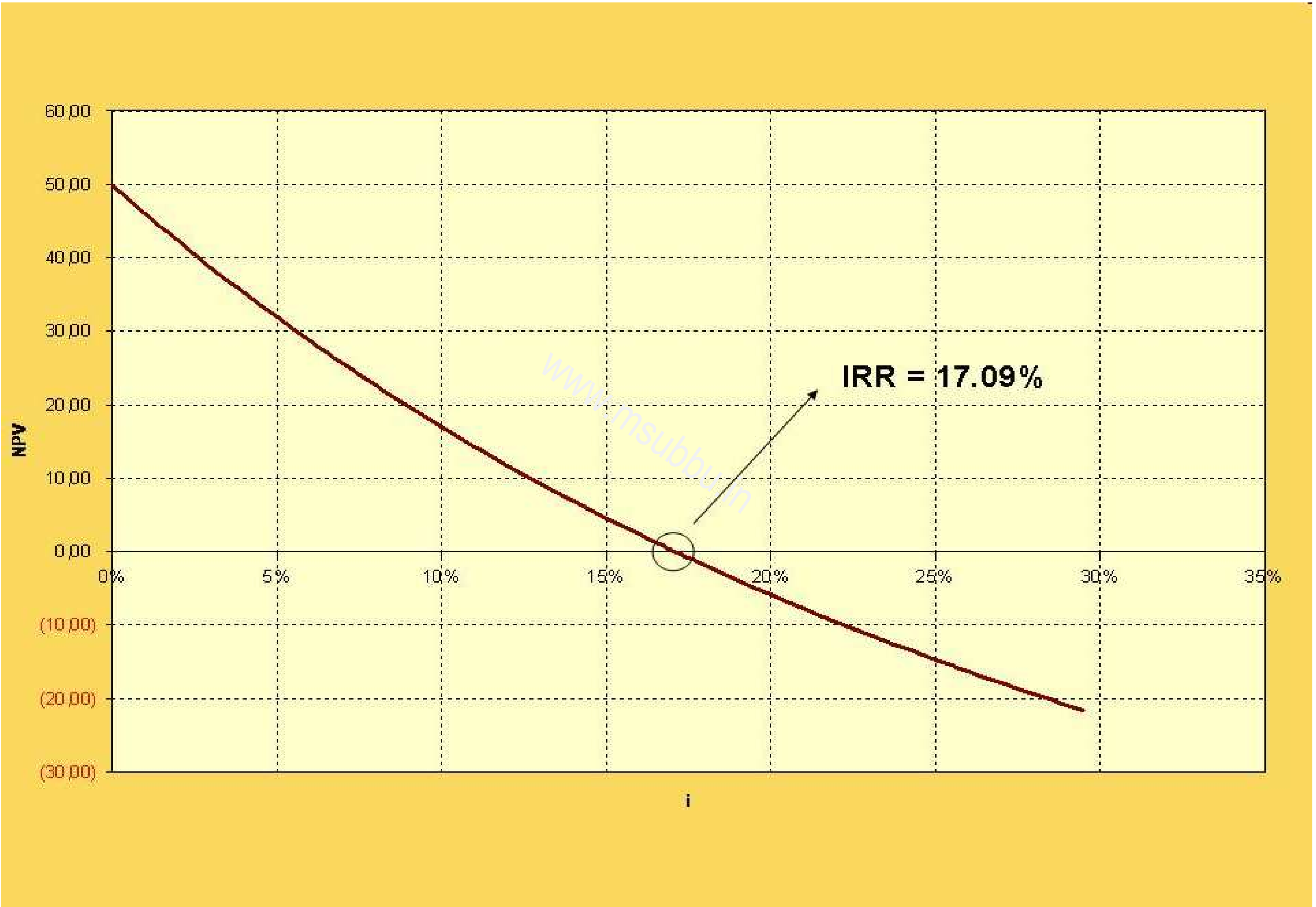
- The internal rate of return on an investment or project is the *annualized effective compounded return rate* or discount rate that makes the net present value of all cash flows (both positive and negative) from a particular investment equal to zero.

$$\mathrm{NPV} = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n} = 0$$

- An investment is considered acceptable if its internal rate of return is greater than an established minimum acceptable rate of return.

- An IRR higher than the standard discount rate indicates that you should go ahead with the project, and when you are choosing among alternative projects, a higher IRR is preferred. If project A earns an IRR of 15 per cent, for example, whereas the ordinary project earns 10 per cent, then project A is an attractive investment.

Internal Rate of Return



MS Fine Chemicals is planning for an investment of Rs. 60 crore and the expected cash inflows from the above investment are as follows:
Calculate internal rate of return. If the expected rate of return is 16%, advice whether the investment proposal can be accepted or not?

Year	1	2	3	4	5
Cash inflow (Rs.)	25 crore	20 crore	25 crore	20 crore	20 crore

Capitalized Cost

It is the cost of providing an investment for a specified duty or service on a perpetual basis.

For an equipment of a fixed capital cost $\boldsymbol{C_{FC}}$ which is having a life of **n** years, the capitalized cost of the equipment $\boldsymbol{C_K}$ is defined by the equation:

$$(C_{\mathrm{K}} - C_{\mathrm{FC}})(1+i)^n = C_{\mathrm{K}} - S$$

$$C_{\mathrm{K}} = \left[C_{\mathrm{FC}} - \frac{S}{(1+i)^n}\right]\left[\frac{(1+i)^n}{(1+i)^n - 1}\right]$$

Capitalized Cost – Example

A piece of equipment has been installed at a cost of Rs. 10,000/-. It is expected to have a working life of nine years with no scrap value. Calculate the capitalized cost of the equipment based on an annual interest rate of 6 percent.

$$
\begin{aligned}
C_{\mathrm{K}} &= C_{\mathrm{FC}}\left[\frac{(1+i)^n}{(1+i)^n-1}\right] \\
&= 10,000\left[\frac{(1+0.06)^9}{(1+0.06)^9-1}\right] \\
&= 24,504
\end{aligned}
$$

Capitalized cost = Rs. 24,504/-

Investment Alternatives

- A number of numerical methods are available for determining the choice between alternatives, the most common being:
  - Net present worth
  - Rate of return
  - Capitalized cost
  - Equivalent uniform annual cost

NPV

Case 1: Single project, unconstrained budget, 'go' or 'no go' decision

Decision rule 1: Do not undertake projects whose NPV is less than zero, unless you are willing to 'lose money' to achieve a non-economic objective.

Example 6.2.1

	NPV	Decision
Project A	+$3	Accept
Project B	+$0	Indifferent
Project C	- $1	Reject

Case 2: Alternative projects, constrained budget, a 'best set' decision

Decision rule 2: Given a choice among alternative projects, maximize the total NPV.

You can rank projects by their NPVs without worrying about the scale of the project. In contrast, you cannot rank projects by their internal rates of return unless you consider their scale as well

IRR

Limitation 1: Simple comparisons between IRRs may be misleading if the projects are not the same size. A project with an IRR of 7 per cent is not necessarily a better choice than one with an IRR of 6 per cent. The size of each project and the discount rate can influence which project is best.

Example 6.3.1

	Project A	**Project B**
Total cost	$100	$10,000
IRR	7%	6%
Discount rate	5%	5%

If you choose project A, you will have $100 earning 7 per cent plus the residual $9,900 earning 5 per cent (total return = $7 + $495 = $502). If you choose project B, you will have the whole $10,000 earning 6 per cent ($600). Project B is better, even though it has a lower IRR than project A.

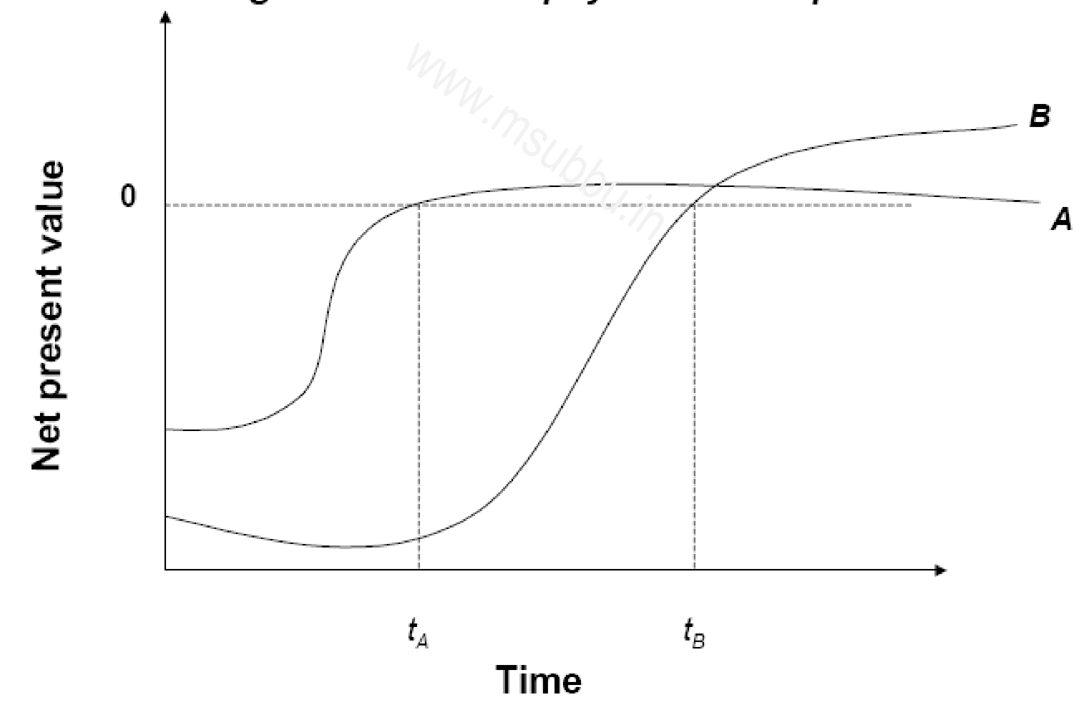
Limitation 2: In many cases, more than one value of the IRR will solve the equation, and it may not be apparent to the analyst that other equally good values exists because the computer typically stops when it finds any acceptable value of the IRR.

Multiple values of the IRR (some negative, some positive) are especially likely if the annual net cash flow of the project alternates between positive and negative figures, a common event because of the cyclical re-capitalisation requirements of projects and/or fluctuations in the prices of inputs and outputs. In some cases, analysts 'bend' the accounting rules to obtain a cash-flow pattern that gives a single value for the IRR, but this is not a satisfactory solution. At best, the possible existence of multiple values of the IRR throws a shadow over its use; at worst, it may lead to incorrect choices among projects.

Payback period

The payback period is the time it takes for the cumulative present value of benefits to become equal to the cumulative present value of costs. In general, shorter payback periods are better. However, this can be a misleading decision rule because it ignores everything that happens after the payback point. It is quite possible for a project to have a higher NPV and a longer payback period (see Figure 6.4.1). 'A' has a quicker payback, but 'B' reaches a higher NPV.

Figure 6.4.1: Two 'paybacks' compared



Best practice - decision rules

NPV decision rules are best. Other decision rules should be used with extreme care.

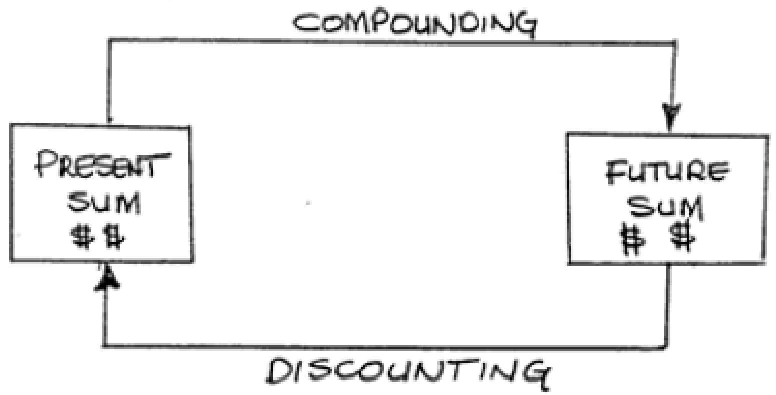
The two basic decision rules are the following:

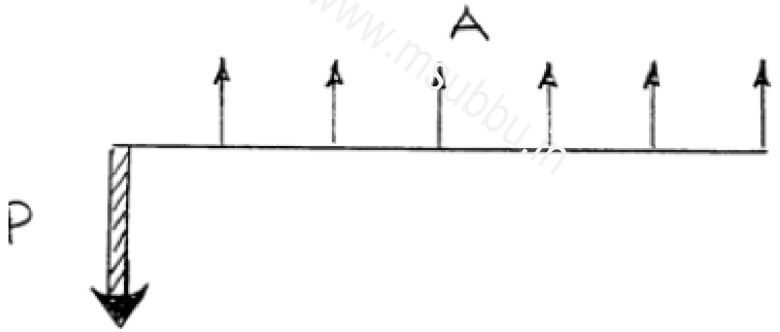
1. Do not undertake projects whose NPV is less than zero, unless you are willing to 'lose money' to achieve a non-financial objective.

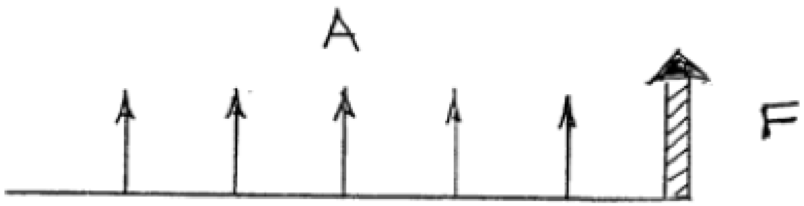
2. Given a choice among alternative projects, maximize the total NPV.

Equivalent Uniform Annual Cost Method

- This method is also known as the uniform annual cost or "unacost" method
- The uniform annual cost is obtained by calculating the present worth of all cash flows associated with the operation through the use of assigned interest rate for discounting purposes.
- The preferred alternate is the one with the least (or less) negative uniform annual cost or the greatest (or greater) positive uniform annual cost that reflects the most (greater) net gain. Remember the convention that costs are negative.


COMPOUNDING
PRESENT SUM $$
FUTURE SUM $ $
DISCOUNTING


A
P


A
F

- If a person purchased a new car for 6000 USD. and sold it 3 years later for 2000 USD., what is the Equivalent Uniform Annual Cost if he spent 750 USD., per year for upkeep and operation? Use an interest rate of 15 % per year.
- Solution:

EUAC = 750 + 6000(A/P, 15%, 3) - 2000(A/F, 15%, 3)

= 750 + 6000(0.15(1+0.15)^3 / (1+0.15)^3-1)) - 2000(0.15/(1+0.15)^3-1))

= 2801.92 USD year.

This means that the above cash flow scheme is equivalent to the payment of 2801.92 USD. per year. Figure below illustrates this equivalence.