ENGINEERING ECONOMICS

(CSE-305)

LECTURE: 04

Applications of Money – Time Relationships

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Evaluating Feasibility of Projects

- **Mutually Exclusive Projects:**

  When one of several alternatives that meet the same need is selected, the others will be rejected.

- **Revenue Projects:**

  Projects for which the income generated depends on the choice of project.

- **Service Projects:**

  Projects for which income remains the same, regardless of which project is selected

Evaluating Feasibility of Projects

- **Analysis Period:**

  The time span over which the economic effects of an investment will be evaluated (study period or planning horizon).

- **Required Service Period:**

  The time span over which the service of an equipment (or investment) will be needed.

- **Rationing of Capital:**

  When the amount of capital is insufficient to sponsor all worth investment opportunities.

Minimum Attractive Rate of Return

- To determine whether a proposed capital investment and its associated expenses can be recovered by revenue over time.
- To determine if a return on a capital is sufficiently attractive in view of risks involved.
- The MARR or minimum attractive rate of return is the interest rate at which a firm can always earn or borrow money.
- MARR is generally dictated by management and is the rate at which Net Present Worth analysis should be conducted.

MARR Considerations

- The amount of money available for investment (i.e. equity/ borrowed funds)
- The number of good projects available for investment (alternatives)
- The type of organization involved (i.e. Government, Public, Private etc)
- The amount of perceived risks associated with investment opportunities available

Evaluation Methods

1. Present Worth Method
2. Future Worth Method
3. Annual Worth Method
4. Internal Rate of Return
5. Benefit Cost Ratio
6. Payback Method

Present Worth Method

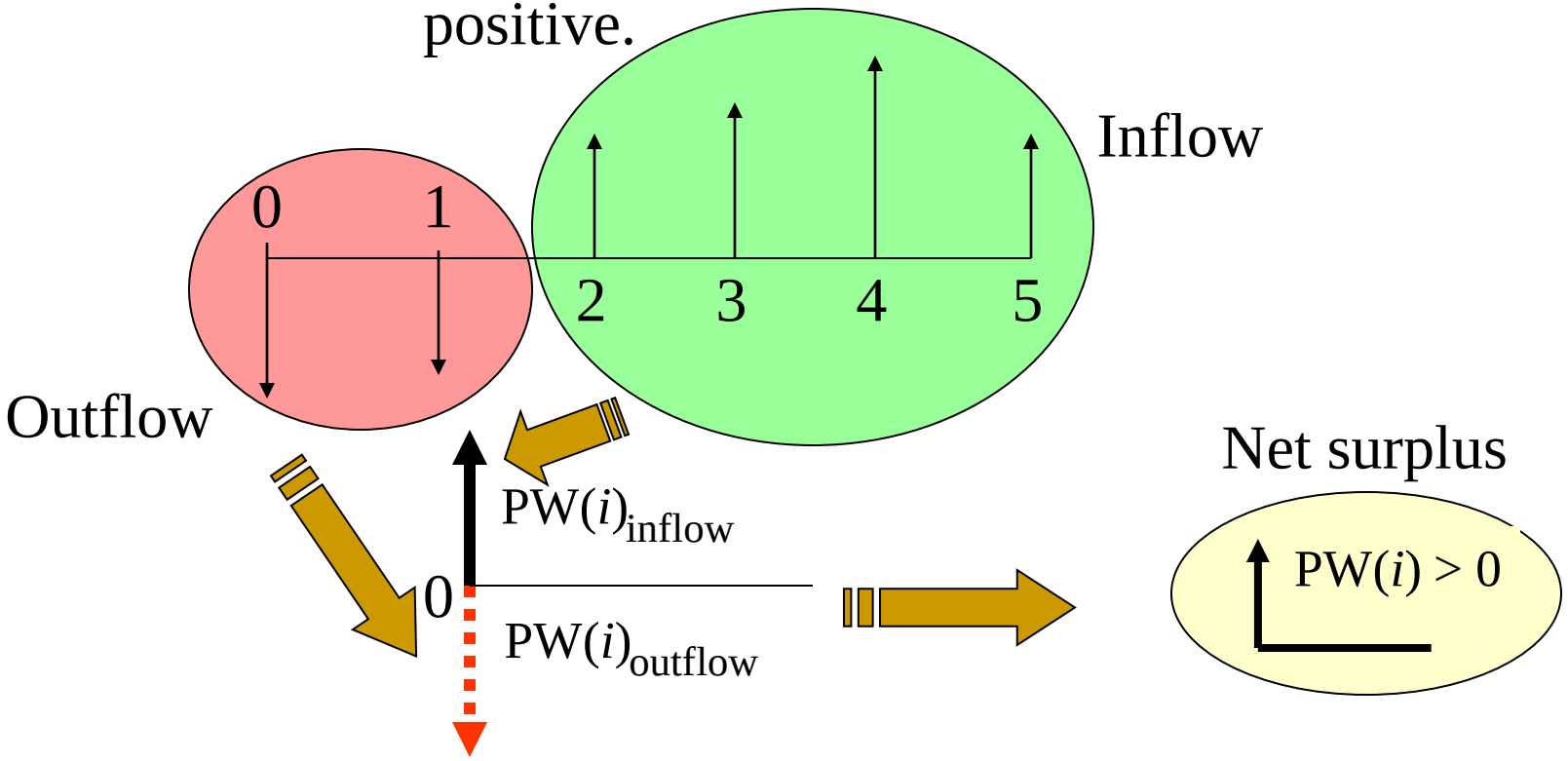
- Equivalent worth of all cash flows relative to some base or beginning point
- All cash inflows and outflows are discounted to the base point at an interest rate that is generally the MARR
- The PW of an investment alternative is a measure of how much money can be afforded to pay for an investment in excess of its cost

$$PW(i\%) = \sum_{k=0}^{N} F_k(1+i)^{-k}$$

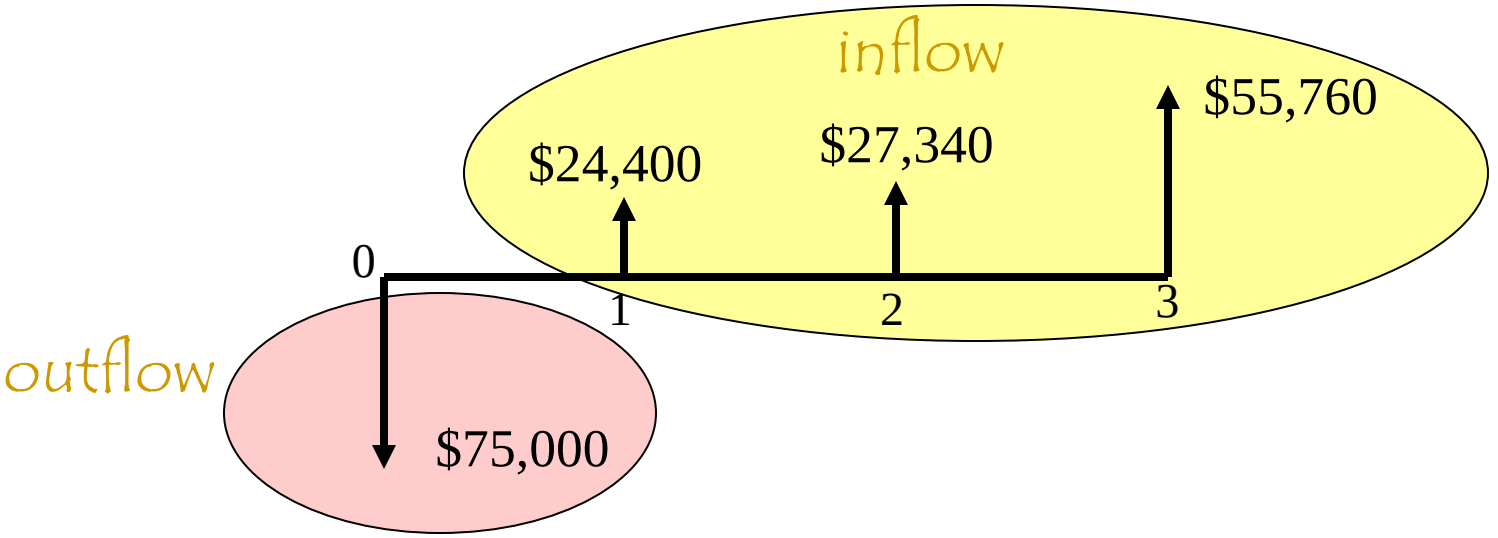
- **As long as the Present Worth is equal to or greater than zero, the project is economically sound**

Net Present Worth Measure

- **Principle:** Compute the equivalent net surplus at $n = 0$ for a given interest rate of i.
- **Decision Rule:** Accept the project if the net surplus is positive.



Example:



$$PW(15\%)_{\text{inflow}} = \$24{,}400(P/F,15\%,1) + \$27{,}340(P/F,15\%,2)$$
$$+\$55{,}760(P/F,15\%,3)$$
$$= \$78{,}553$$
$$PW(15\%)_{\text{outflow}} = \$75{,}000$$
$$PW(15\%) = \$78{,}553 - \$75{,}000$$
$$= \$3{,}553 > 0, \text{ Accept}$$

Example 4.3 (also check 4.2)

Initial Investment = $25,000

Salvage Value = $5,000 at the end of 5 years

Increased Productivity = $8,000 each year

Study Period = 5 years

MARR = 20% per year

Solution:

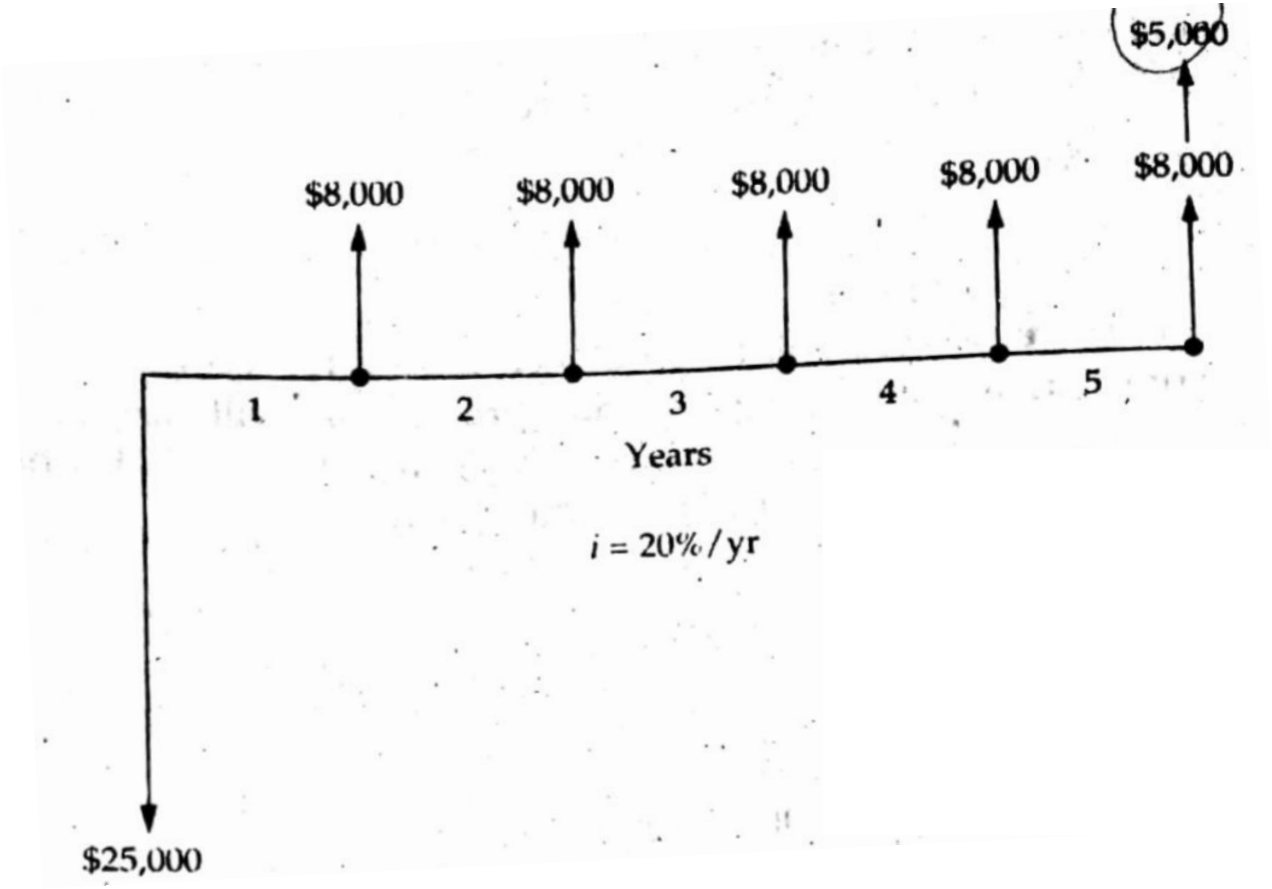
Total PW = PW of Cash Receipts – PW of Cash Outflows

PW(20%) = $8,000 (P/A, 20%, 5) + $5,000 (P/F, 20%, 5) - $25,000

= $934.29

As PW(20%) = $934.29 > 0, this project is economically sound

Cash Flow for Example 4.3

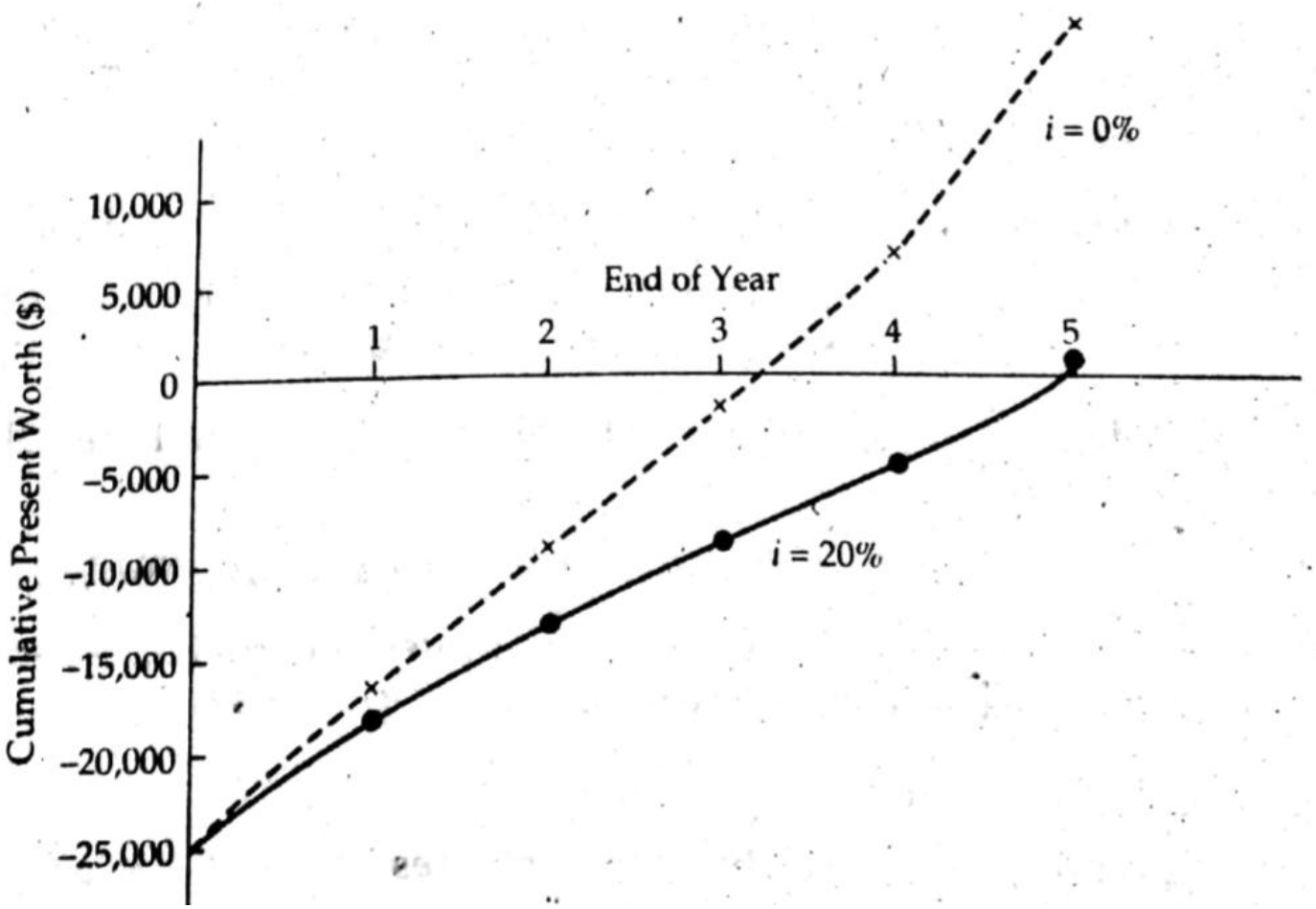


Cumulative PW for Example 4.3

TABLE 4-1 Cumulative PW Calculations for Example 4-3

End of Year k	(A) Cash Flow	(B) Present Worth of Cash Flow at i = 20%	(C) Cumulative PW at i = 20% through Year k	(D) Cumulative PW at i = 0% through Year k
0	−$25,000	−$25,000	−$25,000	−$25,000
1	8,000	6,667	− 18,333	− 17,000
2	8,000	5,556	− 12,777	− 9,000
3	8,000	4,630	− 8,147	− 1,000
4	8,000	3,858	− 4,289	7,000
5	13,000	5,223	− 934	20,000

Graph of Cumulative PW for Example 4.3



Application of Present Worth Method

Bond Value:

- The valuation of bond is the an example of commercial value being the PW of future value
- It is a technique for determining the theoretical fair value of a particular bond
- The bond borrower have to pay two types of payments to the bond owner

i. The present value of the bond's future interest payments (Zr)

ii. The bond's value upon maturity (C)

There are N payments of (i) in the form of Annuity

Bond Value

The Present of the Bond is the sum of two values:

$$V_N = C\,(P/F, i\%, N) + Zr\,(P/A, i\%, N)$$

V_N = *the PW of Bond*

C = *Redemption or disposal price*

Z = *the face value/ par value of bond*

r = *the bond rate per interest period*

Zr= the value of bond upon maturity

i = *the yield/ interest rate*

N = *number of period before maturity / redemption*

Check book Example 4.4 - 4.6

Future Worth Method

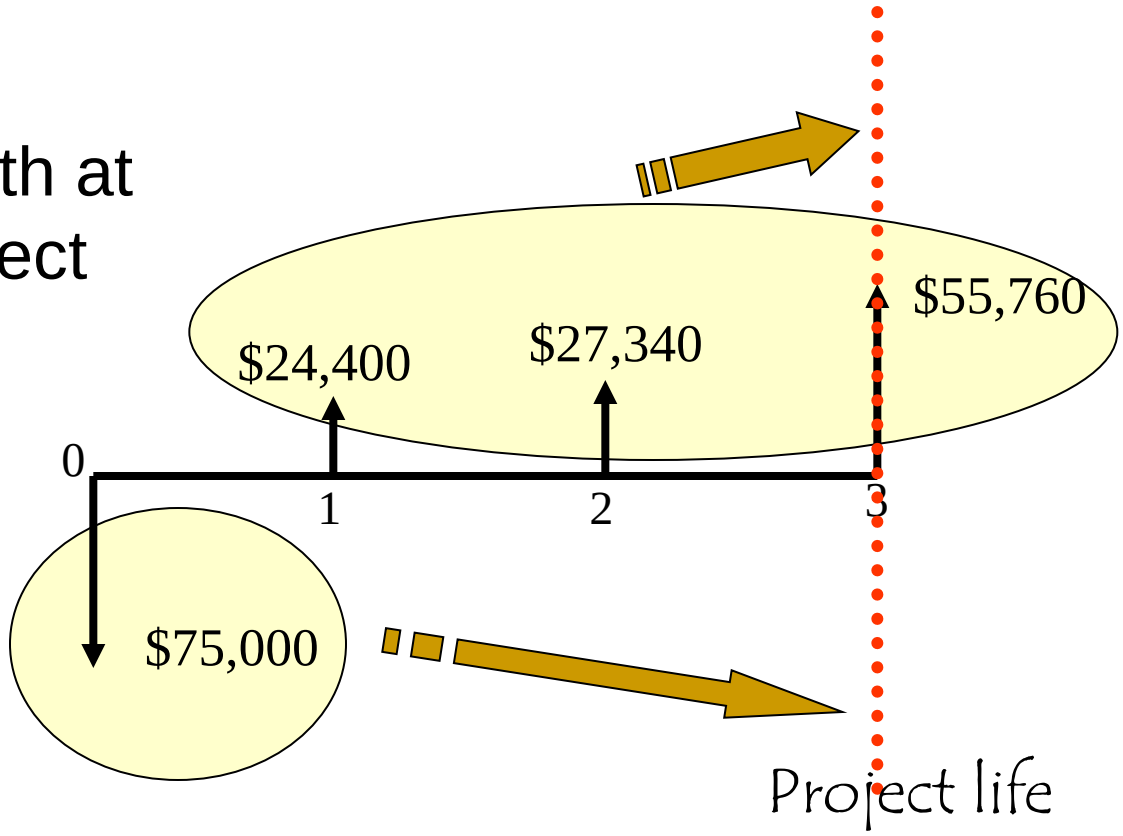
- Equivalent worth of all cash flows relative to some reference point in future
- All cash inflows and outflows are accumulated to the reference point at an interest rate that is generally the ***MARR***
- The FW of an investment alternative is a measure of how much money can be afforded to pay for an investment in excess of its cost

$$PW(i\%) = \sum_{k=0}^{N} F_k(1+i)^{-k}$$

As long as the Future Worth is equal to or greater than zero, the project is economically sound

Future Worth Method

- **Given:** Cash flows and MARR (*i*)
- **Find:** The net equivalent worth at the end of project life



Future Worth Method

$$FW(15\%)_{\text{inflow}} = \$24{,}400(F/P,15\%,2) + \$27{,}340(F/P,15\%,1)$$
$$+\$55{,}760(F/P,15\%,0)$$
$$= \boxed{\$119{,}470}$$

$$FW(15\%)_{\text{outflow}} = \$75{,}000(F/P,15\%,3)$$
$$= \boxed{\$114{,}066}$$

$$FW(15\%) = \$119{,}470 - \$114{,}066$$
$$= \boxed{\$5{,}404 > 0,\ \text{Accept}}$$

Check book Example 4.7

Annual Worth Method

- Measure an investment worth on annual basis
- Uniform Annual series of all cash flows for stated study period
- Annual Worth is equal to annual equivalent revenues (***R***) minus annual expenses (***E***) less its annual equivalent capital recovery (***CR***) cost

$$AW(i\%) = R - E - CR(i\%)$$

As long as the Annual Worth is equal to or greater than zero, the project is economically sound

Capital Recovery Cost

- The Capital Recovery Cost is equivalent to uniform annual cost of capital
- Its an Annual Amount that covers:
  - ***Loss in value of asset***
  - ***Interest on invested Capital***

$$CR\,(i\%) = I\,(A/P, i\%, N) - S\,(A/F, i\%, N)$$

  - ***I* = Initial investment in project**
  - ***S* = Salvage value**

Capital Recovery Cost

- Another way to calculate CR is to add annual sinking fund amount to interest on original investment (minimum required profit)

$$CR\,(i\%) = (I - S)\,(A/F, i\%, N) + I\,(i\%)$$

- Yet another popular way to calculate CR is to equivalent annual cost of uniform loss in value investment to interest on salvage value

$$CR\,(i\%) = (I - S)\,(A/P, i\%, N) + S\,(i\%)$$

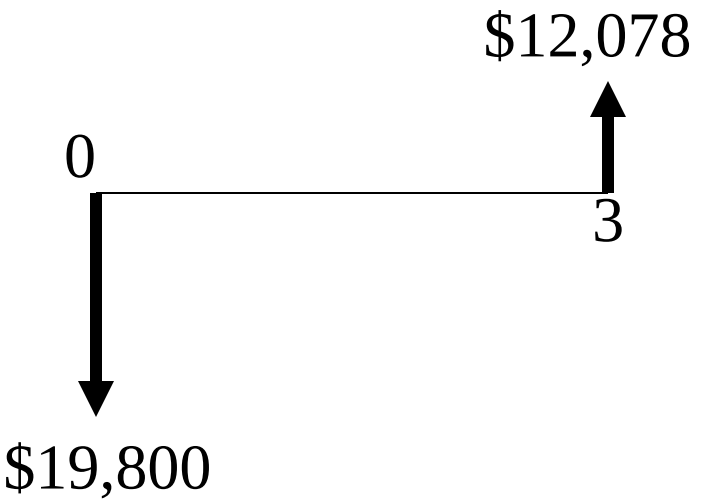
Check book Example 4.8 - 4.9

Example - Capital Cost Calculation

- **Given:**

  ***I* = $19,800**
  ***N* = 3 years**
  ***S* = $12,078**
  ***i* = 6%**

- **Find: CR(6%)**



$$CR\,(i) = (I\text{-}S)\,(A/P, i, N) + iS$$

$$CR\,(6\%) = (\$19{,}800 - \$12{,}078)\,(A/P, 6\%, 3) + (0.06)\$12{,}078$$

$$= \$3{,}613.55$$

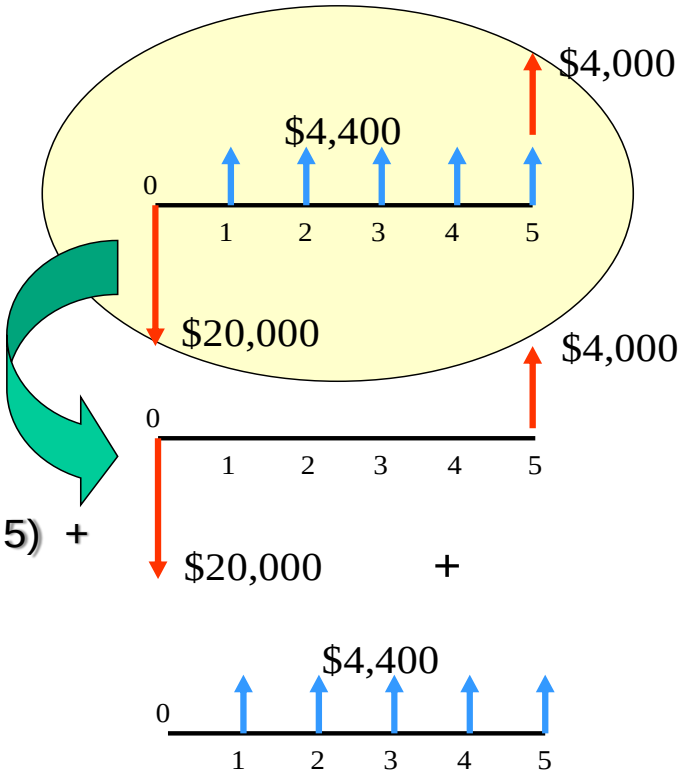
Example – Annual Worth Analysis

- **Given:**

  I = \$20,000,
  S = \$4,000,
  N = 5 years,
  i = 10%

- **Find:** See if an annual revenue of \$4,400 is large enough to justify the initial investment.

- **Solution:**



CR(10%) = (20,000-4000)(A/P, 10%, 5) +
4000 (10%)
= \$4,620.76

AW(10%) = 4400 - 4620.76

Conclusion: Need an additional annual revenue in the amount of \$220.76.