Department of Mechanical Engineering, Pulchowk campus, Institute of Engineering, Tribhuvan University

ENGINEERING ECONOMICS

Project Evaluation Techniques

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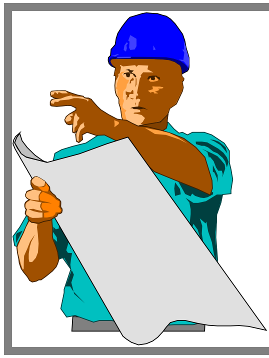
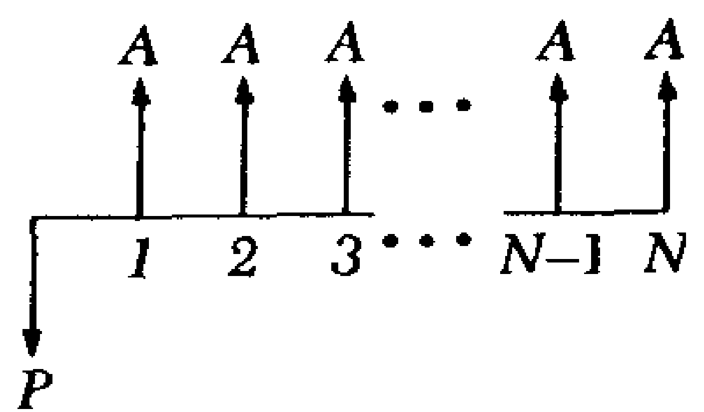
Lecture 6



Project Cash flows

In most of the **engineering economic decision problems**, we usually make an **initial investment at the beginning** of the project. Then this investment will **make a series of cash benefits** over a period of future years.

The representation of future earnings along with the initial capital expenditure and annual expenses such as wages, raw material costs, operating costs, maintenance costs, and income taxes is called the **project cash flows**.



Project Evaluation techniques

With the **background of knowledge of interest rate and time value of money**, we can evaluate whether a **project is feasible or not** on the **basis of cash flow equivalence methods**.

These techniques are also called **Capital Budgeting techniques** in finance.

Evaluation of Project

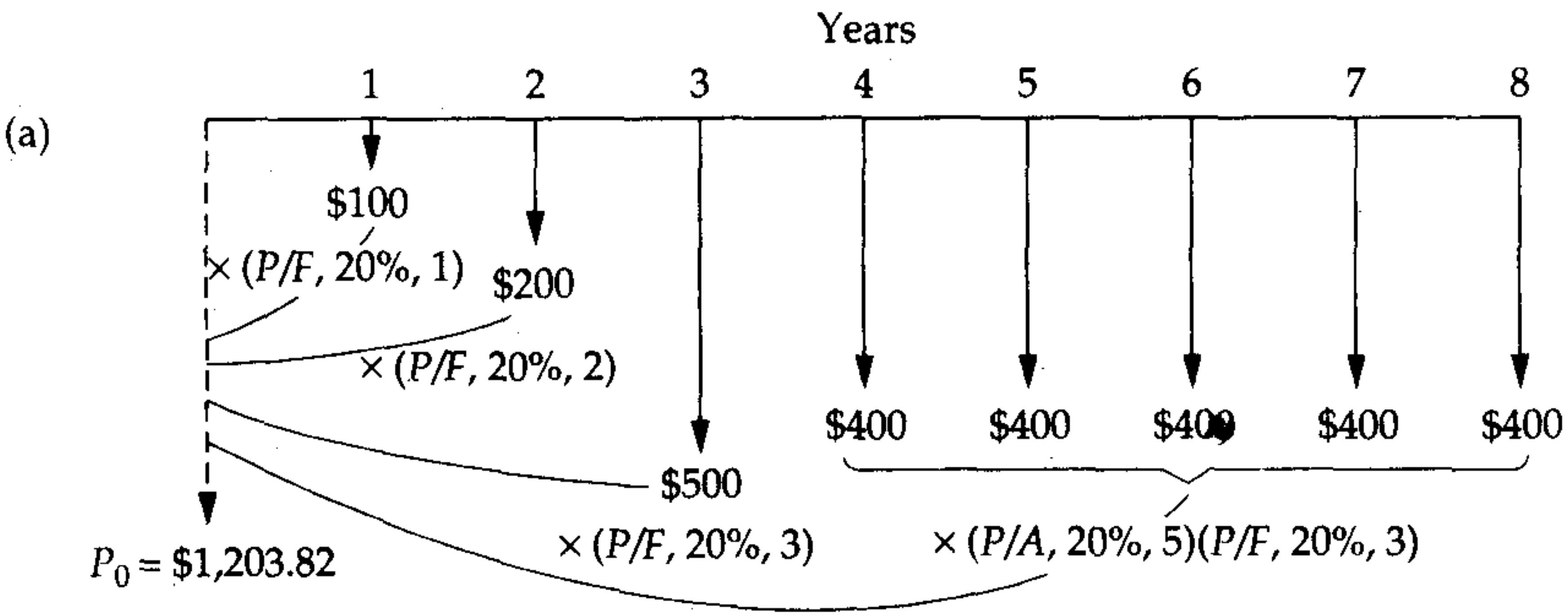
We can evaluate a project or select a project from different alternatives by the following methods:

a) ***Equivalent Present Value (worth) method***

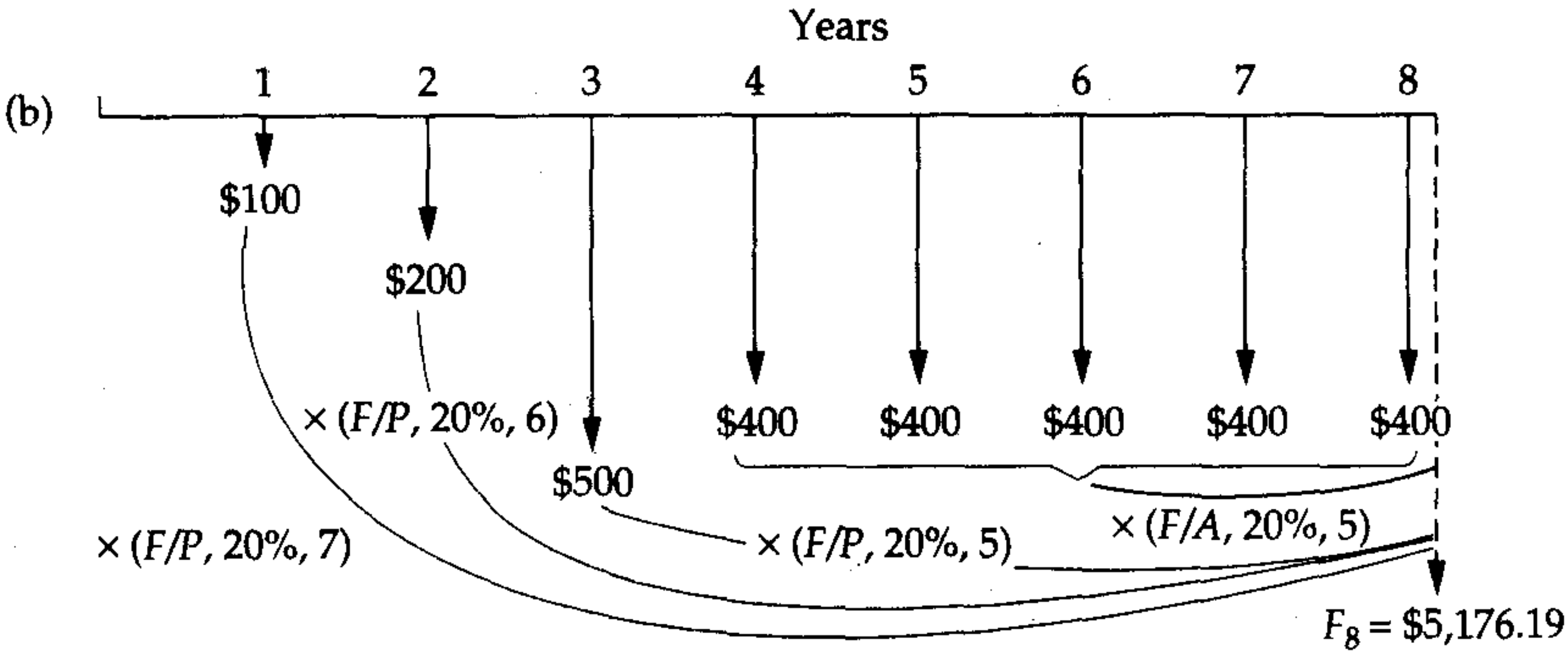
b) ***Equivalent Future Value (worth) method***

c) ***Equivalent Annual Value (worth) method***

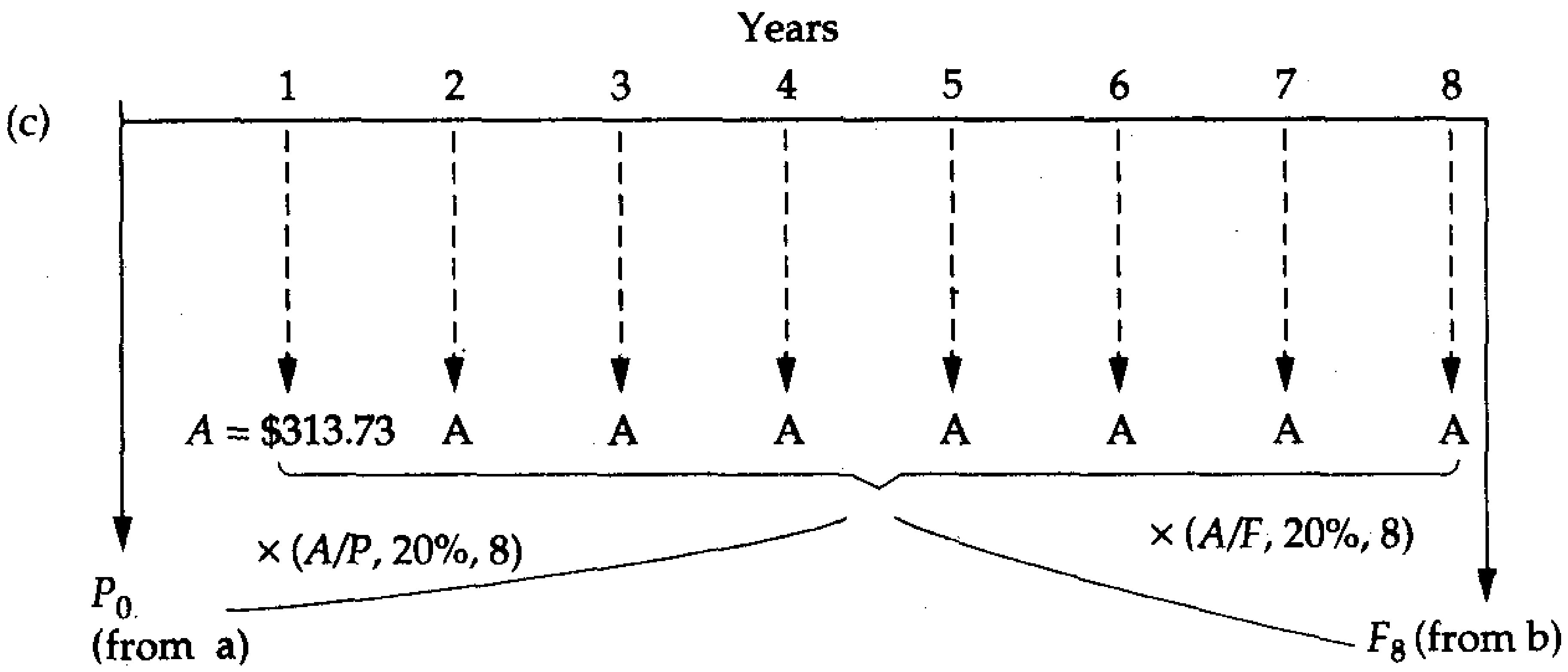
Equivalent Present Value (worth) method



Equivalent Future Value (worth) method



Equivalent Annual Value (worth) method



Apart from the above, we can evaluate a project on the basis of

Payback Period

and

Internal Rate of Return (IRR)

Payback Period Method

The payback period is the number of years required to recover the investment made in a project.

Example:

Initial Investment = Rs 300,000

Annual Net benefits = Rs 75,000

Payback period

= Initial investment/ Uniform Annual benefit

=4 years

Benefits & flaws of Payback period method

Benefit: simplicity

Flaws: **failure to measure profitability** of project & **no time value of money** consideration

Discounted Payback Period

To modify the payback period method, we may **consider the cost of fund (interest)** used to support the project. This modified method is called *discounted payback period*.

Discounted Payback period N occurs, when

$$\sum_{0}^{N} \text{Discounted Annual Benefit} \geq \text{Initial Investment}$$

By hit and trial method we determine the value of N

$$\sum_{k=1}^{\theta}(R_k - E_k) - I \geq 0$$

TABLE 4-4 Calculation of the Simple Payback Period (θ) and the Discounte- Payback Period (θ') at MARR = 20% for Example 4-3[a]

Col. 1 End of Year k	Col. 2 Net Cash Flow	Col. 3 Cumulative *PW* at i = 0%/yr. through Year k	Col. 4 Present Worth of Cash Flow at i = 20%/yr.	Col. 5 Cumulative *PW* at MARR = 20%/yr. through Year k
0	−$25,000	−$25,000	−$25,000	−$25,000
1	8,000	−17,000	6,667	−18,333
2	8,000	−9,000	5,556	−12,777
3	8,000	−1,000	4,630	−8,147
4	8,000	+7,000	3,858	−4,289
5	13,000	+20,000	5,223	+934
		↑ θ = 4 years because the cumulative balance turns positive at EOY 4		↑ θ' = 5 years because the cumulative discounted balance turns positive at EOY 5

Present Value Analysis

Until 1950s, the payback period method was widely used as a means of making investment decisions. As there are flaws in this method, businessmen began to search methods for improving the project evaluations. This led to the development of ***Discounted Cash Flow (DCF)*** techniques, which take account of time value of money. One of the DCF methods is ***Net Present Value (NPV)*** method.

Net Present Value (NPV) method

Under NPV method, PV of all cash inflows are compared with PV of all cash outflows. The difference between these PV's is called Net Present Value (NPV).

NPV Criterion

The basic procedure for applying this criterion:

1. Determine the required rate of interest the firm wants. This interest rate is called **required rate of return (ROR)** or **minimum attractive rate of return (MARR)**.
2. Estimate the **service life** of the project
3. Estimate the **cash inflow** for each period of the service life
4. Estimate the **cash outflow** for each period of service life
5. Determine the **net cash flows**
6. Find the **present value of each net cash flow** discounted **at the MARR**.
7. **Add up the PV's** including the initial investment. Their sum is defined as the NPV of the project

$$NPV = A_0/(1+i)^0 + A_1/(1+i)^1 + A_2/(1+i)^2 + \ldots\ldots + A_n/(1+i)^n$$

$$NPV = \sum_{n=0}^{N} A_n (P/F, i, n)$$

If NPV > 0, **accept** the investment

If NPV = 0, **remain indifferent**

If NPV< 0, **reject** the investment.

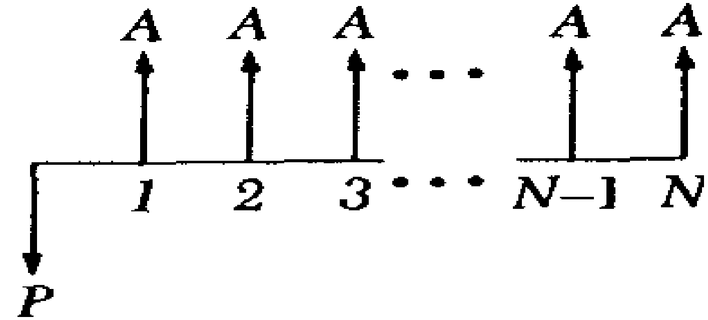
A micro-hydro project example

Calculate the **NPV** for the scheme assuming a **12% discount factor**
Revenue: NRs. 300,000 each year for 15 years
Initial Investment: NRs. 1,200,000.
Yearly expenditure (O & M, salary and others)**: NRs. 80,000**.

Solution,
The **annual net income** is **NRs. 220,000**.
The **total present value (PV) of receiving this annuity** amount **for 15 years** is

$$PV = A \times \left[\frac{(1+i)^n - 1}{i(1+i)^n} \right] = A(P/A, i, n)$$

$$= \quad NRs.1,496,000$$

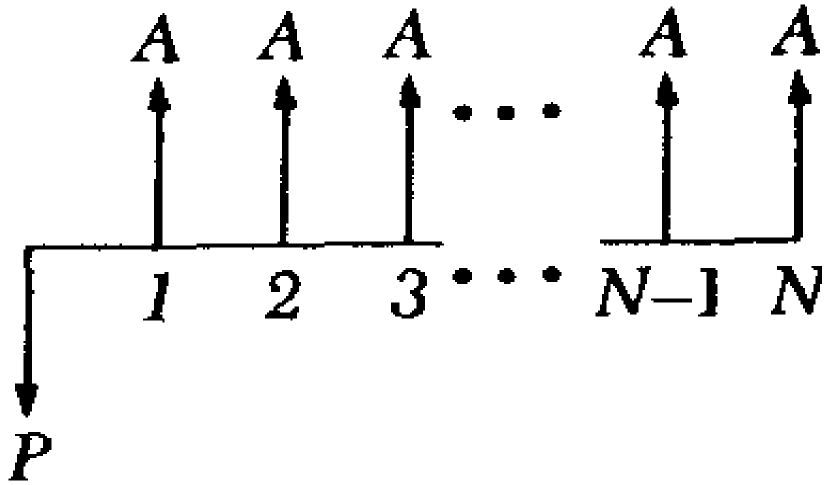


NPV (r=12%) = PV – investment

= NRs.1,496,000 – 1,200,000 = **NRs. 296,000** > 0

Example 1

If a project's initial investment is Rs 300,000 and gives an equal annual savings of Rs 75,000 for next 10 years. If the company wants MARR of 15%, determine the NPV of the project.



APPENDIX A Interest Factors for Discrete Compounding

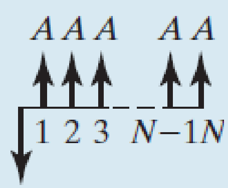
15.0%

	Single Payment		Equal Payment Series				Gradient Series		
N	**Compound Amount Factor (F/P,i,N)**	**Present Worth Factor (P/F,i,N)**	**Compound Amount Factor (F/A,i,N)**	**Sinking Fund Factor (A/F,i,N)**	**Present Worth Factor (P/A,i,N)**	**Capital Recovery Factor (A/P,i,N)**	**Gradient Uniform Series (A/G,i,N)**	**Gradient Present Worth (P/G,i,N)**	**N**
1	1.1500	0.8696	1.0000	1.0000	0.8696	1.1500	0.0000	0.0000	1
2	1.3225	0.7561	2.1500	0.4651	1.6257	0.6151	0.4651	0.7561	2
3	1.5209	0.6575	3.4725	0.2880	2.2832	0.4380	0.9071	2.0712	3
4	1.7490	0.5718	4.9934	0.2003	2.8550	0.3503	1.3263	3.7864	4
5	2.0114	0.4972	6.7424	0.1483	3.3522	0.2983	1.7228	5.7751	5
6	2.3131	0.4323	8.7537	0.1142	3.7845	0.2642	2.0972	7.9368	6
7	2.6600	0.3759	11.0668	0.0904	4.1604	0.2404	2.4498	10.1924	7
8	3.0590	0.3269	13.7268	0.0729	4.4873	0.2229	2.7813	12.4807	8
9	3.5179	0.2843	16.7858	0.0596	4.7716	0.2096	3.0922	14.7548	9
10	4.0456	0.2472	20.3037	0.0493	5.0188	0.1993	3.3832	16.9795	10

Present worth $(P/A, i, N)$

$$P = A\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right]$$

$=\mathrm{PV}(i, N, A,, 0)$



Capital recovery $(A/P, i, N)$

$$A = P\left[\frac{i(1+i)^N}{(1+i)^N - 1}\right]$$

$=\mathrm{PMT}(i, N,, P)$

Example 2

Tiger Machine Tool Company is considering the proposed acquisition of a new metal-cutting machine. The required initial investment of Rs 750,000 and the projected cash benefits for three years are as follows:

End of year	Cash flow
0	- Rs 750,000
1	Rs 244,000
2	Rs 273,400
3	Rs 557,600

If the company wants MARR is 15%, determine the NPV of the project?

APPENDIX A Interest Factors for Discrete Compounding

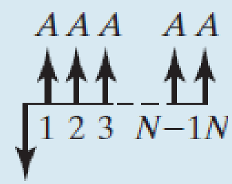
15.0%

	Single Payment		Equal Payment Series				Gradient Series		
N	Compound Amount Factor (F/P,i,N)	Present Worth Factor (P/F,i,N)	Compound Amount Factor (F/A,i,N)	Sinking Fund Factor (A/F,i,N)	Present Worth Factor (P/A,i,N)	Capital Recovery Factor (A/P,i,N)	Gradient Uniform Series (A/G,i,N)	Gradient Present Worth (P/G,i,N)	N
1	1.1500	0.8696	1.0000	1.0000	0.8696	1.1500	0.0000	0.0000	1
2	1.3225	0.7561	2.1500	0.4651	1.6257	0.6151	0.4651	0.7561	2
3	1.5209	0.6575	3.4725	0.2880	2.2832	0.4380	0.9071	2.0712	3
4	1.7490	0.5718	4.9934	0.2003	2.8550	0.3503	1.3263	3.7864	4
5	2.0114	0.4972	6.7424	0.1483	3.3522	0.2983	1.7228	5.7751	5
6	2.3131	0.4323	8.7537	0.1142	3.7845	0.2642	2.0972	7.9368	6
7	2.6600	0.3759	11.0668	0.0904	4.1604	0.2404	2.4498	10.1924	7
8	3.0590	0.3269	13.7268	0.0729	4.4873	0.2229	2.7813	12.4807	8
9	3.5179	0.2843	16.7858	0.0596	4.7716	0.2096	3.0922	14.7548	9
10	4.0456	0.2472	20.3037	0.0493	5.0188	0.1993	3.3832	16.9795	10

Present worth $(P/A, i, N)$

$$P = A\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right]$$

$=PV(i, N, A,, 0)$



Capital recovery $(A/P, i, N)$

$$A = P\left[\frac{i(1+i)^N}{(1+i)^N - 1}\right]$$

$=PMT(i, N,, P)$

Example 3

A textile company is considering two **independent investment** proposals. Their expected cash flow streams are given as follows:

Year	Proj. A	Proj. B	Year	Proj. A	Proj. B
0	-250,000	-350,000	6	72,500	70,000
1	72,500	60,000	7		70,000
2	72,500	60,000	8		70,000
3	72,500	60,000	9		70,000
4	72,500	70,000	10		70,000
5	72,500	70,000			

If the company wants MARR is 12%, which proposals should be accepted to the company? Perform NPV analysis

12.0%

	Single Payment		Equal Payment Series				Gradient Series		
N	Compound Amount Factor (F/P,i,N)	Present Worth Factor (P/F,i,N)	Compound Amount Factor (F/A,i,N)	Sinking Fund Factor (A/F,i,N)	Present Worth Factor (P/A,i,N)	Capital Recovery Factor (A/P,i,N)	Gradient Uniform Series (A/G,i,N)	Gradient Present Worth (P/G,i,N)	N
1	1.1200	0.8929	1.0000	1.0000	0.8929	1.1200	0.0000	0.0000	1
2	1.2544	0.7972	2.1200	0.4717	1.6901	0.5917	0.4717	0.7972	2
3	1.4049	0.7118	3.3744	0.2963	2.4018	0.4163	0.9246	2.2208	3
4	1.5735	0.6355	4.7793	0.2092	3.0373	0.3292	1.3589	4.1273	4
5	1.7623	0.5674	6.3528	0.1574	3.6048	0.2774	1.7746	6.3970	5
6	1.9738	0.5066	8.1152	0.1232	4.1114	0.2432	2.1720	8.9302	6
7	2.2107	0.4523	10.0890	0.0991	4.5638	0.2191	2.5515	11.6443	7
8	2.4760	0.4039	12.2997	0.0813	4.9676	0.2013	2.9131	14.4714	8
9	2.7731	0.3606	14.7757	0.0677	5.3282	0.1877	3.2574	17.3563	9
10	3.1058	0.3220	17.5487	0.0570	5.6502	0.1770	3.5847	20.2541	10
11	3.4785	0.2875	20.6546	0.0484	5.9377	0.1684	3.8953	23.1288	11
12	3.8960	0.2567	24.1331	0.0414	6.1944	0.1614	4.1897	25.9523	12
13	4.3635	0.2292	28.0291	0.0357	6.4235	0.1557	4.4683	28.7024	13
14	4.8871	0.2046	32.3926	0.0309	6.6282	0.1509	4.7317	31.3624	14
15	5.4736	0.1827	37.2797	0.0268	6.8109	0.1468	4.9803	33.9202	15

Practice

- 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.9