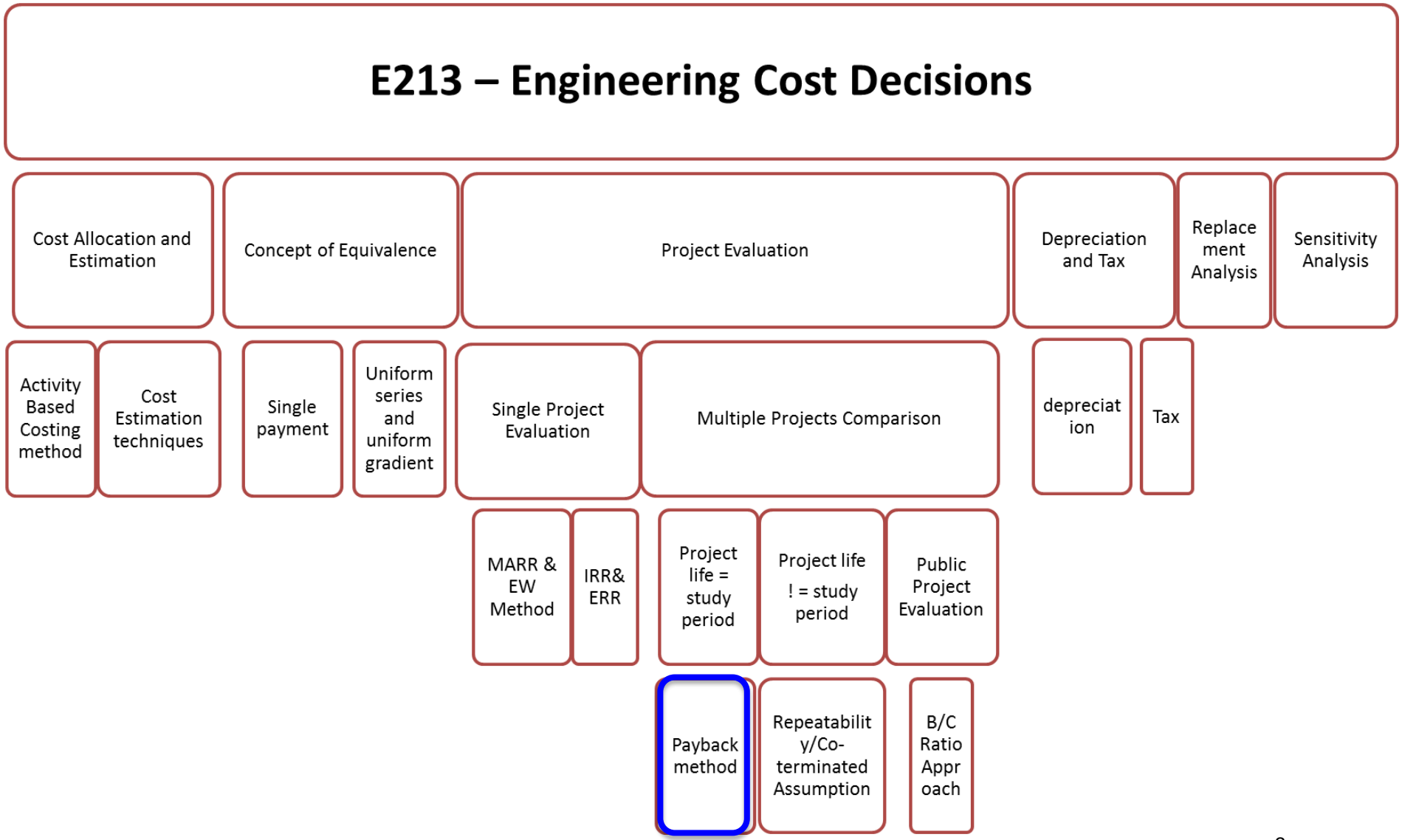
Problem 07

Collaborative Robots

E213 – Engineering Cost Decisions

SCHOOL OF ENGINEERING

Module Coverage: Topic Tree



Payback Method

- The payback method screens the project based on how long it takes for the project to achieve breakeven cost status.
- The payback period is an indication of the liquidity as well as risk involved in the investment.
- Ignores cash flows after the payback period.
- NOT a measurement of the profitability of investment.

Simple Payback Method

- Ignores the time value of money.
- The simple payback period, **minimum θ**, is simply:

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

Where,

R_k = Revenue in year k

E_k = Expenditure in year k

I = Initial investment

Discounted Payback Method

- Time value of money is considered and therefore the discounted cash flows are used
- Inclusion of interest rate (Time Value of Money) will increase the payback period
- The discounted payback period, **minimum θ'**, is determined by:

$$\sum_{k=1}^{\theta'} (R_k - E_k)(P/F, i\%, k) - I \geq 0$$

Where,

R_k = Revenue in year k
E_k = Expenditure in year k
I = Initial investment
i% = MARR

Mutually Exclusive Alternatives

- We are comparing ***Mutually Exclusive*** Alternatives
  - Can only choose one of the alternatives out of a group of projects
- Comparison of mutually exclusive alternatives can be demonstrated with two examples:
  1. Investment alternatives (make as much $$$profit as you can) : Initial Investment that produce positive cash flows from increased revenue, savings through reduced costs, or both
  2. Cost alternatives (cut as much $$$cost as you can: All negative cash flows except for a possible positive cash flow from disposal of assets at the end of project's useful life

Recall: Evaluating Single Project

- So far we are only evaluating single project:
  - **Equivalent Worth Method**
    - ➢ Net PW>0 or Net AW>0 or Net FW>0 at MARR

      => Project is feasible
  - **IRR/ERR Method**
    - ➢ If IRR/ERR > MARR

      => Project is feasible

How to make Comparison of 2 or more Alternatives with Lives Equal to the Study Period?

Study Period & Useful lives of alternatives

- The study (analysis) period, sometimes called the planning horizon, is the selected time period over which mutually exclusive alternatives are compared.
- Today we focus on: Comparison of Alternatives with Lives **Equal to** the Study Period using Equivalent Worth Method
  - When the useful life of an alternative is equal to the selected study period, adjustments to the cash flows are NOT required.
- When the project life span of all alternatives are equal to the study period, then the best alternative is the one which:
  - For the investment alternatives, has the greatest positive equivalent worth (PW, FW, or AW) at MARR.
  - For the cost alternatives, has the least negative equivalent worth (PW, FW, or AW) at MARR.

Example: Alternatives with Lives Equal to the Study Period

Evaluate three mutually exclusive alternatives. Given the MARR is 12% per year, and the analysis period is 10 years, use Net Present Worth (NPW) method to determine which alternatives are economically acceptable and which one should be selected.

	I	II	III
Capital Investment	$110,000	$142,000	174,000
Net Profit / Year	$ 14,200	$ 32,000	35,000
Salvage Value (End of Useful Life)	$ 10,000	$ -	15,000
Useful Life (Years)	10	10	10

Alt I: NPW(12%) = -110,000 + 14,200(P|A,12%,10) + 10,000(P|F,12%,10)
= (26,547)

Alternative I is not feasible, NPV<0

Alt II: NPW(12%) = -142,000 + 32,000(P|A,12%,10)
= **38,807**

Select Alternative II because it has the highest NPW

Alt III: NPW(12%) = -174,000 + 35,000(P|A,12%,10) + 15,000(P|F,12%,10)
= 28,587

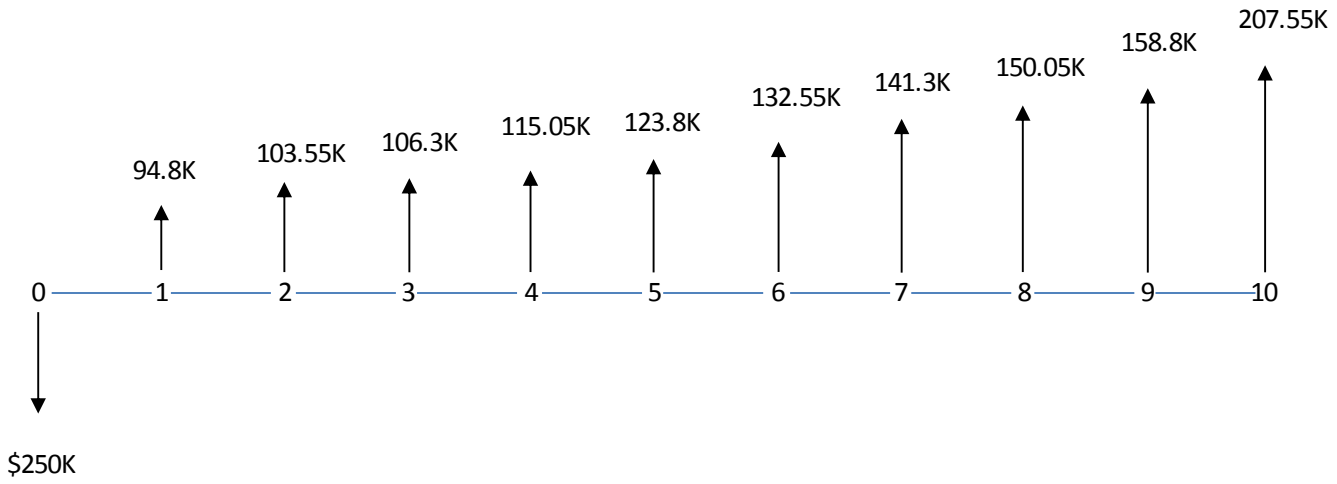
P07 Suggested Solution

Problem Statement

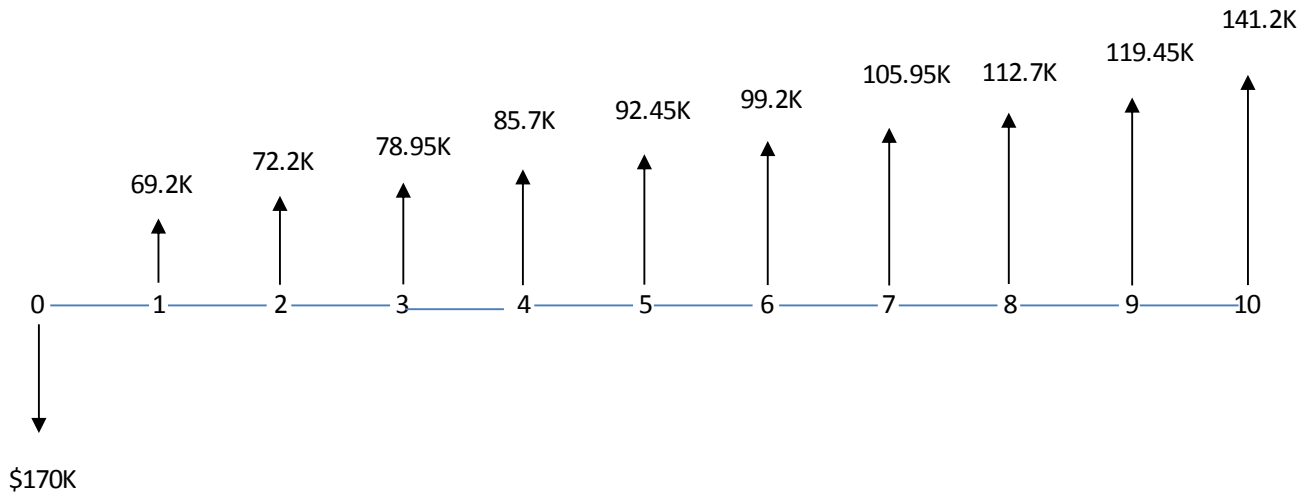
- MARR of 32%
- Evaluate the Payback Period for purchasing a cobot: FormX or UltraZ
- Comparison of Alternatives with Lives Equal to the Study Period using Equivalent Worth Method

Cash Flow Diagrams

FormX:



UltraZ:



FormX

FormX

End of Period	Net Cash Flow ($)	Cumulative PW @ i=0%/yr ($)	PW of cash flow @ i=32%/yr ($)	Cumulative PW @ i=32%/yr ($)
0	($250,000)	($250,000)	($250,000)	($250,000)
1	$94,800	($155,200)	$71,818	($178,182)
2	$103,550	($51,650)	$59,430	($118,752)
3	$106,300	$54,650	$46,218	($72,534)
4	$115,050	$169,700	$37,896	($34,638)
5	$123,800	$293,500	$30,892	($3,746)
6	$132,550	$426,050	$25,057	$21,311
7	$141,300	$567,350	$20,236	$41,547
8	$150,050	$717,400	$16,280	$57,827
9	$158,800	$876,200	$13,052	$70,879
10	$207,550	$1,083,750	$12,924	$83,803

Simple Payback Method:
Payback @ end of Year 3

Discounted Payback Method:
Payback @ end of Year 6

UltraZ

UltraZ

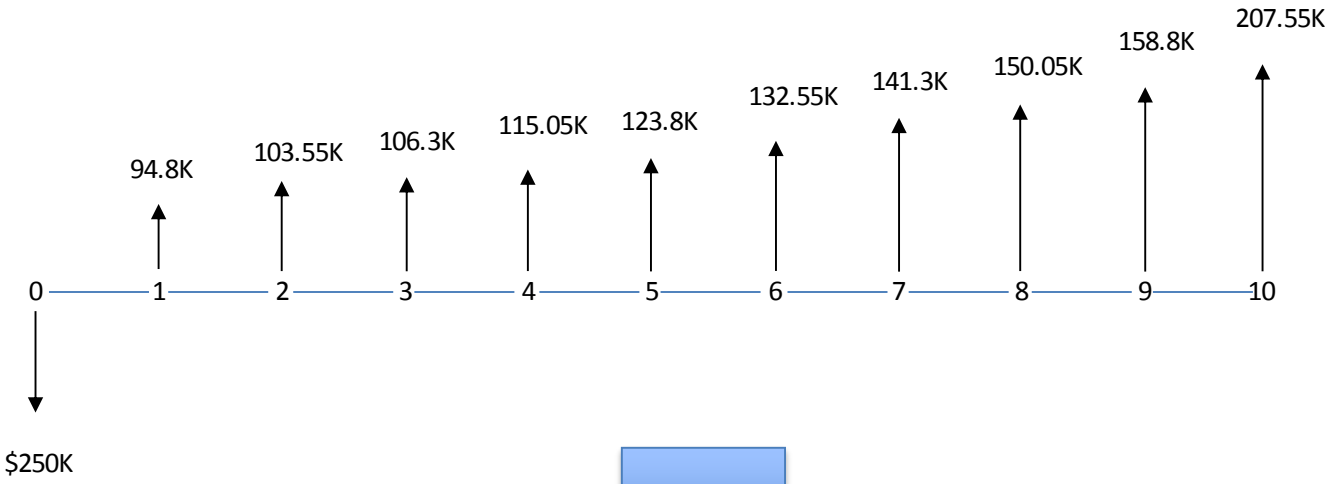
End of Period	Net Cash Flow ($)	Cumulative PW @ i=0%/yr ($)	PW of cash flow @ i=32%/yr ($)	Cumulative PW @ i=32%/yr ($)
0	($170,000)	($170,000)	($170,000)	($170,000)
1	$69,200	($100,800)	$52,424	($117,576)
2	$72,200	($28,600)	$41,437	($76,139)
3	$78,950	$50,350	$34,327	($41,812)
4	$85,700	$136,050	$28,228	($13,584)
5	$92,450	$228,500	$23,069	$9,486
6	$99,200	$327,700	$18,753	$28,239
7	$105,950	$433,650	$15,173	$43,412
8	$112,700	$546,350	$12,227	$55,639
9	$119,450	$665,800	$9,818	$65,457
10	$141,200	$807,000	$8,792	$74,249

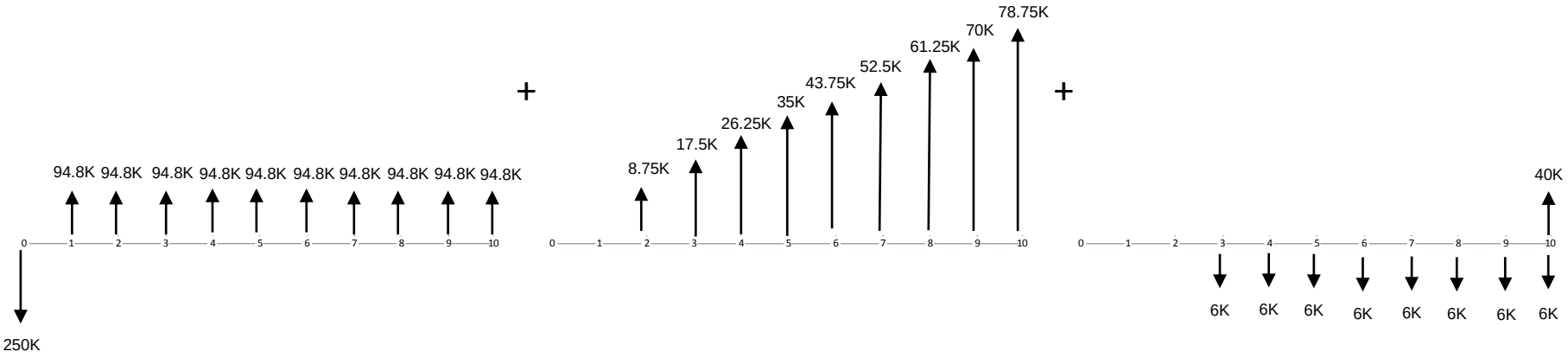
Simple Payback Method:
Payback @ end of Year 3

Discounted Payback Method:
Payback @ end of Year 5

Cash Flow Diagrams

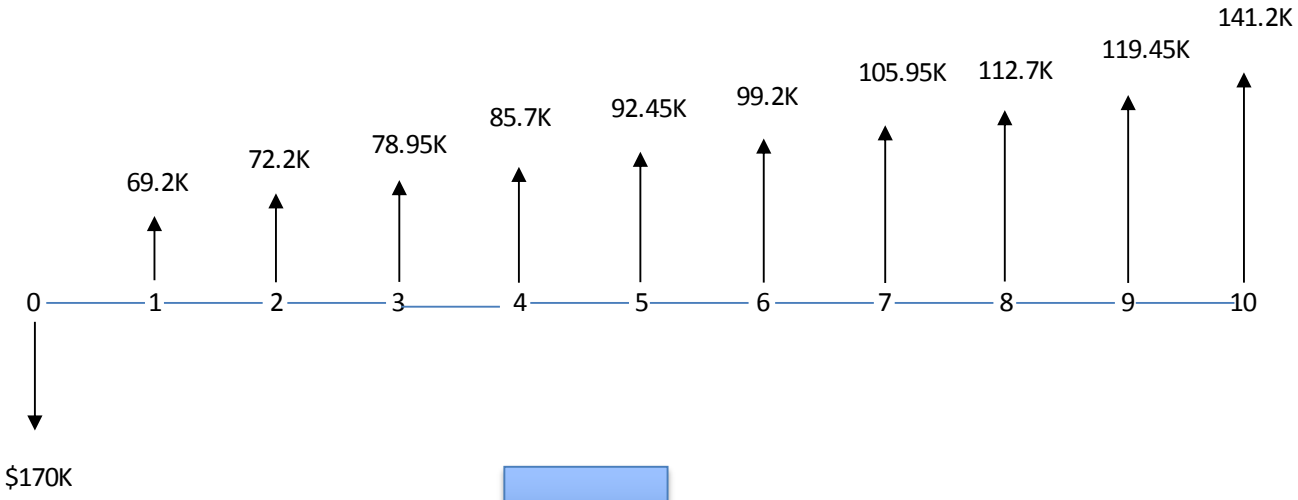
FormX:

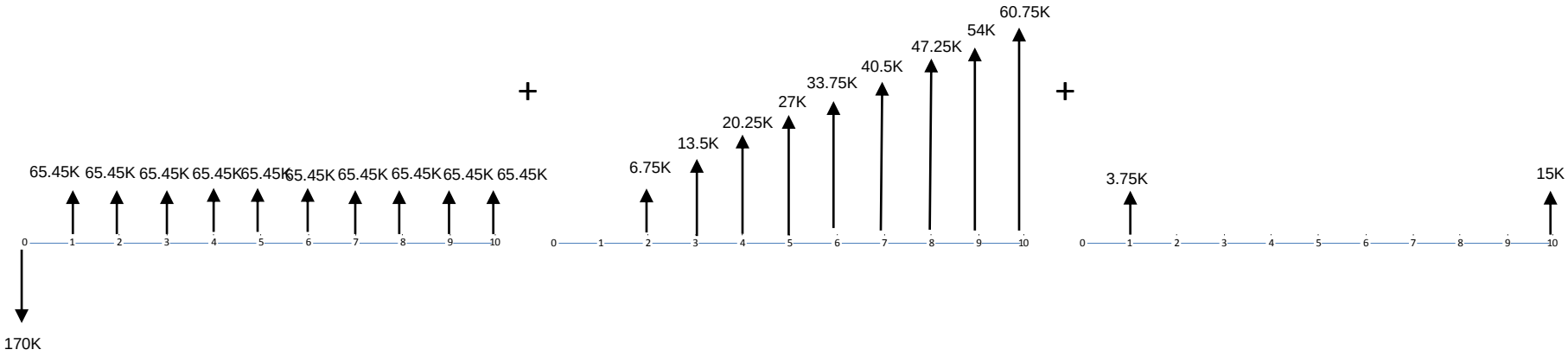




Cash Flow Diagrams

UltraY:





Equivalent Worth Comparisons

FormX:

PW (32%)
= -250,000 - 6,000(P/A,32%,8)*(P/F,32%,2) + 94,800(P/A,32%,10) + 8,750 (P/G,32%,10) + 40,000(P/F,32%,10)
= -250,000 - 6,000*2.786*0.5739 + 94,800*2.9304 + 8,750*7.2117+ 40,000*0.0623
= $83,802.75

UltraZ:

PW (32%)
= -170,000 + 3,750(P/F,32%,1) + 65,450(P/A,32%,10) + 6,750 (P/G,32%,10) + 15,000(P/F,32%,10)
= -170,000 + 3,750*0.7576 + 65,450*2.9304 + 6,750 *7.2117 + 15,000*0.0623
= $74249.16

Equivalent Worth Comparisons

	FormX	UltraZ
End of Period	**Net Cash Flow ($) per period**	**Net Cash Flow ($) per period**
0	($250,000)	($170,000)
1	$94,800	$69,200
2	$103,550	$72,200
3	$106,300	$78,950
4	$115,050	$85,700
5	$123,800	$92,450
6	$132,550	$99,200
7	$141,300	$105,950
8	$150,050	$112,700
9	$158,800	$119,450
10	$207,550	$141,200
	$ 83,803	$ 74,249.44

=NPV(32%,B29:B38)+B28

=NPV(32%,C29:C38)+C28

Comparison

	FormX	UltraZ
Simple Payback Period	3 years	3 years
Discounted Payback Period	6 years	5 years
Present Worth	$83,803	$74,249

- **Payback Period**
  Based on shorter payback criterion, UltraZ will be better.
- **Equivalent Worth**
  Based on net present worth criterion, FormX will be better.
- **Which is the better option then?**
  - Payback Method ignores the cash flows after the payback period.
  - Payback Period only indicates how long it takes for the project to break even. The longer it takes, the perceived risk of project will be greater.
  - Dependent on the company's strategy and risk profile.
  - Generally, you should avoid using payback method alone to decide go or no-go for a project.

Learning Objectives

- Differentiate the two payback methods: Simple payback VS. discounted payback method
- Apply the concept of payback period to evaluate investment feasibility using
  - ✓ Simple Payback method
  - ✓ Discounted Payback method
- Compare mutually exclusive alternatives with Project Life Span Equal to the Study Period using the concept of Equivalent Worth (EW) method

E213 Engineering Cost Decisions (Topic Flow)

Today's learning

Application of ABC costing method in cost management

Application of different cost estimating techniques

Comparison of alternatives using the concept of equivalence

Alternatives evaluation using single, uniform series and uniform gradient cash flows

Project evaluation using MARR and Equivalent Worth method

Project evaluation based on Internal Rate of Return and External Rate of Return

Evaluate alternatives of equal life spans using payback method

Evaluate alternatives with different life spans

Evaluate public projects through incremental B/C analysis

Depreciation estimation and consideration in economic analysis

Tax consideration in economic analysis

Replacement analysis application

Risk and uncertainties handling in economic analysis