Engineering Economy Practice Problems

For

Exam 3

By

Douglas Rittmann

1. From the analysis of mutually exclusive revenue projects shown below, identify the one(s) which should be selected

Project ID	A1	B1	C1	D1
PW @ i = MARR	-$5000	$300	$2000	-$1500

Answer: C1

The results from an economic analysis of independent alternatives are shown below. Identify which one(s) should be selected:

Project ID	A2	B2	C2	D2	E2
PW @ i = MARR	$200	$2,000	-$700	-$3,200	$4,200

Answer: A2, B2, E2

2. From the economic analysis results for the *independent projects* shown below, determine which one(s) should be selected

Project ID	X1	X2	X3	X4	X5
PW @ I = MARR	-$700	-$3000	-$1200	-$1000	-$5000

Answer: None

From the economic analysis results for the *mutually exclusive revenue projects* shown below, determine which one(s) should be selected

Project ID	Z1	Z2	Z3	Z4
PW @ I = MARR	-$2500	-$1000	-$3000	-$7000

Answer: NONE

3. Compare the alternatives shown below on the basis of their present worths using an interest rate of 15% per year.

	Alt C	Alt D
First cost, $	$12,000	$18,000
Annual M&O Cost, $/yr	5,000	4,000
Salvage value, $	3,000	6,000
Life, years	5	5

Solution: The present worths of each alternative are as follows:

PWC = -12,000 – 5,000 (P/A, 15%, 5) + 3,000 (P/F, 15%, 5)
= -12,000 – 5,000 (3.3522) + 3,000 (0.4972)
= -$27,269

PWD = -18,000 – 4,000 (P/A, 15%, 5) + 6,000 (P/F, 15%, 5)
= -18,000 – 4,000 (3.3522) + 6,000 (0.4972)
= -$28,426

Answer: PWC

PW for Different-Life Alternatives

When conducting a present worth comparison of alternatives which have different lives, it is necessary to adopt a procedure which yields present worths for *equal service*. This must be done because by definition, a present worth value is the single number which represents the equivalent worth of all cash flows. Clearly, when the alternatives under consideration involve only costs, the one with the shortest life will likely have the lowest present cost, even if it is not the most economical one.

There are two procedures for insuring that the comparison is made for equal service:

(1) Compare the alternatives over the least common multiple (LCM) of their lives, or

(2) Compare the alternatives over a specified time horizon. In the first case, it is commonly assumed that the cash flows associated with the first life cycle will be the same in all succeeding life cycles. In the second case, all cash flows are assumed to terminate at the end of a specified study period, with residual salvage values estimated for the remaining life of the assets involved.

$$P = A / i$$

The procedure to find the capitalized of cash flows which contain an infinite series is:

1. Find the PW of all finite-interval cash flows using the regular engineering economy formulas (P/F, P/A, P/G, etc)

2. Convert all (non-annual) *recurring* amounts into annual worths over one life cycle and add all A values together

3. Divide the A values obtained in step (2) by i to get the PW of the annual amounts.

4. Add all PW's together to get the capitalized cost.

The next example illustrates the calculations involved.

Prob. #4: A dam will have a first cost of $5,000,000, an annual maintenance cost of $25,000 and minor reconstruction costs of $100,000 every five years. At an interest rate of 8% per year, the capitalized cost of the dam is

Solution:

The $5,000,000 first cost is already a present worth. The $100,000 which occurs every five years can be converted into an infinite A value using the A/F factor for one life cycle. Dividing the A values by i and adding to the $5,000,000 PW will yield the capitalized cost, CC.

$$CC = -5{,}000{,}000 - 25{,}000/0.08 - 100{,}000\,(A/F, 8\%, 5) / 0.08$$
$$= -5{,}000{,}000 - 312{,}500 - 100{,}000\,(0.1705)/0.08$$
$$= -\$5{,}525{,}625$$

The AW method is commonly used for comparing alternatives. As illustrated in Chapter 4, AW means that all incomes and disbursements (irregular and uniform) are converted into an equivalent uniform annual (end-of-period) amount, which is the *same each period*. The major advantage of this method over all the other methods is that it does not require making the comparison over the least common multiple (LCM) of years when the alternatives have different lives. That is, the AW value of the alternative is calculated for *one life cycle only*.

5. At an interest rate of 18% per year, the annual worth of an asset which has a first cost of \$50,000, an annual operating cost of \$30,000, and a \$10,000 salvage value after a 4-year life is

$$
\begin{aligned}
AW &= -50{,}000\,(A/P,\ 18\%,\ 4) - 30{,}000 + 10{,}000\,(A/F,\ 18\%,\ 4) \\
&= -50{,}000\,(0.37174) - 30{,}000 + 10{,}000\,(0.19174) \\
&= -\$46{,}670
\end{aligned}
$$

A rate of return equation is generally set up with 0 on the left hand side of the equation and all other values on the right hand side preceded by the proper sign. A common general equation is:

$$0 = -P \pm A\,(P/A, i, n) \pm SV\,(P/F, i, n)$$

When a rate of return equation contains two or more factors (such as the P/A and P/F in this case), a trial and error solution is required. The next example illustrates the procedure.

6. A solid waste recycling company invested $130,000 in sorting equipment. The company had net profits of $40,000 per year for 4 years, after which the equipment was sold for $23,000 (and replaced with more sophisticated equipment). The rate of return per year on the investment was

Solution: The rate of return equation is:

$$0 = -130{,}000 + 40{,}000\,(P/A, i, 4) + 23{,}000\,(P/F, i, 4)$$