Assignment 3

EECE/CPEN 481

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Selected problems listed below are based on textbook problems or directly drawn from the textbook (Engineering Economic Analysis: Fourth Canadian Edition).

Problems are drawn mainly from material in Chapters 6 and 7.

1. Problem 6-11
2. Problem 6-34
3. Problem 6-75
4. Problem 7-26
5. Problem 7-43 (1.5x value)
6. Problem 7-74 (1.5x value)
7. Problem 7-117

Solutions given in blue type.

Assignment 3 Solutions

1. **Problem 6-11**

A firm purchased some equipment at a very favourable price of $30,000. The equipment resulted in an annual net saving of $1,000 a year during the eight years it was used. At the end of eight years, the equipment was sold for $35,000. Assuming interest is 8%, calculate the EUAC accounting for all costs, cost savings, and revenues (rounding to the nearest dollar). Did the equipment purchase prove to be desirable?

Solution:

EUAC = $30,000 ($A/P$, 8%, 8) - $1,000 - $35,000 ($A/F$, 8%, 8)
= $30,000 (0.1740) - $1,000 - $35,000 (0.0940)
= ($930)

The equipment has an annual cost that is greater than the benefits. The equipment purchase did not turn out to be desirable. (This answer looks counter-intuitive – we sell the equipment for more than the purchase price, and it's saving us money every year we own it. But we would be better off if we'd just invested our original $30K at 8% interest.)

2. **Based on Problem 6-34**

Jenny is an engineer for a municipal power plant. The plant uses natural gas, which is currently obtained from an existing pipeline at an annual cost of $110,000 per year. Jenny is considering a project to construct a new boiler. The initial cost to purchase and install the new boiler would be $800,000, but it would reduce the annual natural gas cost to $70,000 per year. Assume the boiler will last 20 years, and that the new boiler will not have any salvage value at the end. Use an interest rate of 4.5%.

a) Determine the equivalent uniform annual cost (EUAC) for the new boiler.
b) Should the new boiler be purchased and installed?

Solution:

(a) EUAC of new boiler = $70,000 + $800,000 ($A/P$, 4.5%, 20)
= $70,000 + $800,000 (0.0769) = $70,000 + $61,501
= **$131,501**

(b) Since the EUAC of the new pipeline is higher than the $110,000 annual cost of the existing system, the new boiler should not be constructed.

3. **Based on Problem 6-75**

An office building with 10,000 ft^2 of leasable space will be purchased. The owner will sell it after 20 years for a price that will recover 40% of the building purchase cost and all of the land purchase cost. It will be leased to commercial clients for the 20 years.

Land	\$4.2M
Building	\$3.5M
Annual operating and maintenance	\$640,000
Annual property taxes and insurance (as % of initial capital investment)	3%

Assume annual costs are distributed evenly across the months in each year.

(a) If the owner wants a 12% rate of return, what is the required monthly leasing cost per square foot, assuming the building is entirely leased out? Assume monthly compounding applies.
(b) Assume instead that the building will be vacant 10% of the time. What will the required monthly leasing cost per actively leased square foot be in this case, to achieve the same rate of return? Round to the nearest cent for both answers.

Solution:

Since monthly compounding applies, interest rate will be 12% / 12 months = 1% per month.

(a) Initial Costs = \$4.2M + \$3.5M = \$7.7M
Selling Price (yr 20) = \$4.2M + (0.40) \$3.5M = \$5.6M
Annual Expenses = \$0.64M + \$7.7 (0.03) = \$0.871M.

C = Monthly Leasing Cost. This is an "A"-type variable: a regularly repeating revenue item.
The building and land will be sold in 20 years = 240 periods into the future.
NPW must = 0
= capital cost + A to P conversion of O&M costs + A to P conversion of lease revenue + salvage value
= – \$7.7M – (\$0.871/12) (*P*/*A*, 1%, 240)+ C (*P*/*A*, 1%, 240) + \$5.6M (*P*/*F*, 1%, 240)
= – \$7.7M – (\$0.0726) (90.819)+ C (90.819) + \$5.6M (0.0918)
C = \$13.777863M / 90.819 = \$151,706

C per square foot = \$151,706 / 10,000 = \$15.17 per square foot

(b) The owner still wants the same amount of revenue, to achieve the 12% return. If the building is empty 10% of the time, then the cost per square foot of leased space will be
\$151,706 / 9,000 = \$16.86 per square foot

4. **Based on Problem 7-26**

Danielle can purchase a municipal bond with a par value (list price) of $7,000 that will mature in five years. The bond pays 6.4% interest. Payments are issued quarterly. If she can buy this bond for $6,720, what effective annual rate of return will she earn, rounded to the nearest tenth of a percent?

Solution:

Determine the interest rate that causes the NPW = 0. There are three components to include: the initial purchase payment, the series of quarterly bond payments (revenues), and the revenue from the return of the bond par value.

Interest paid quarterly = $7,000 (0.064/4) = $112
5 years = 20 quarters
NPW = 0 = -$6,720 + $112 ($P/A$, i%, 20) + $7,000 ($P/F$, i%, 20)

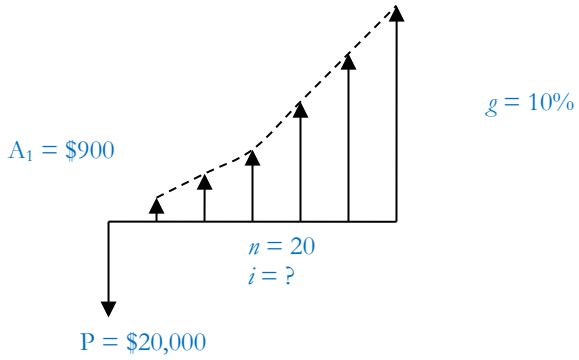
Use Excel or linear interpolation to solve for i.

Quarterly i = 1.84%/qtr
Annual nominal rate = 4 quarters × 1.84% = 7.4%
Effective annual rate = (i + r/m)^m – 1 = 7.6%

5. **Based on Problem 7-43**

A company is offering to sell an annuity for $20,000 cash. In return, the firm will guarantee to pay the purchaser 20 annual end-of-year payments, with the first payment of $1,000. Subsequent payments will increase at a uniform 10% rate each year. What rate of return will the purchaser receive if she buys the annuity, rounded to one decimal place (x.x%)?

Solution:



The payment schedule represents a geometric gradient.
There are two possibilities: $i \neq g$ and $i = g$

Try the easier $i = g$ computation first:

$P = A_1 n (1 + i)^{-1}$ where $g = i = 0.10$

$P = \$1{,}000\ (20)\ (1.10)^{-1} = \$18{,}182$. This isn't equal to the annuity cost of $20,000, so i is not equal to g.

Therefore the other formula must be used:

$$P = A_1 \left[\frac{1 - (1+g)^n (1+i)^{-n}}{i - g} \right]$$

You can use Goal Seek or other methods in Excel, or can use trial and error, to determine a value of i that causes the equation to balance.

i = 9.0%

6. Based on Problem 7-74

Consider three alternatives: A, B, and do nothing. Construct a choice table for these alternatives.

Year	A	B
0	-$100	-$150
1	+30	+42
2	+30	+42
3	+30	+42
4	+30	+42
5	+30	+42

Round your answers to the nearest tenth of a percent (x.x%).

Solution:

First, compute rates of return. This must be done by interpolation, or by using the IRR formula.

$ROR_A = 15.2\%$
$ROR_B = 12.4\%$

Next, do incremental analysis:

Year	(B – A)
0	–$50
1–5	+$12

Determine the interest rate at which these costs and benefits are equal (through more interpolation): that is the differential rate of return.

$\$50 = \$12\ (P/A, i\%, 5)$
$\Delta\ ROR_{B-A} = 6.4\%$

The above calculations give you the info you need to form the choice table.

Choice table:

If 0 < borrowing rate ≤ 6.4 Select B
If 6.4 < borrowing rate ≤ 15.2 Select A
If 15.2< borrowing rate ≤ 100 Do Nothing

7. Problem 7-117

The owner of a corner lot wants to find a use that will yield a desirable return on his investment. After much study and calculation, he decides that the two best alternatives are the following:

	Build Gas Station	Build Soft Ice Cream Stand
First cost	$80,000	$120,000
Annual property taxes	$3,000	$5,000
Annual income	$11,000	$16,000

Neither option is expected to have any salvage value. Both investments are expected to last twenty years. If the owner wants a minimum attractive rate of return on his investment of 6%, which of the two alternatives would you recommend?

Solution:

Year	A (Gas Station)	B (Ice Cream Stand)	(B – A)
0	−$80,000	−$120,000	−$40,000
1−20	+$8,000	+$11,000	+$3,000
Computed IRR	7.75%	6.63%	4.22%

The rate of return if the owner switches their plan from Option A to Option B, as indicated by the incremental internal rate of return, is less than the desired 6%. In this situation the lower cost alternative (A) Gas Station should be selected.