# Assignment 4

## 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 Chapter 8.

1. Problem 1
2. Problem 2 (2x value)
3. Problem 3
4. Problem 4 (1.5x value)
5. Problem 5 (1.5x value)

Solutions given in blue type.

# Assignment 4 Solutions

1. **Problem 1**

List three examples of the potential costs and benefits that should be considered in evaluating a potential nuclear power plant. Give three examples of stakeholder viewpoints that will need to be considered.

**Solution:**

This is a list of some of the potential costs and benefits for a nuclear power plant:

| Costs | Benefits |
|---|---|
| Land acquisition | Environment<br>• No greenhouse gas<br>• No leakage<br>• No combustion |
| Site preparation | Jobs and economy<br>• At enrichment plants<br>• At power plant<br>• Increase tax base |
| Cooling system<br>• Reservoir dams<br>• Reservoir cooling | Increase demand<br>• Uranium plants |
| Construction<br>• Reactor vessel/core<br>• Balance of plant<br>• Spent fuel storage<br>• Water cleaning | |

Examples of potential stakeholders: electricity purchasers (industrial users or say an association concerned about electricity rates for consumers), First Nations communities, nearby residents who will be affected by land acquisition, traffic and potentially by pollution, regulatory agencies (concerning safety or energy pricing, for example), a wider circle of residents and business associations who may be interested in jobs created, government (for permitting, for example).

## 2. Problem 2 (2x value)

The Highridge region needs an additional supply of water from Steep Creek. The engineer has selected two plans for comparison:

*Gravity plan*: Divert water at a point 10 km upstream on Steep Creek and carry it through a pipeline by gravity to the district.

*Pumping plan*: Divert water at a point on Steep Creek that is nearer to the district, and pump it through 2 km of pipelines to the district. The pumping plant can be built in two stages, with the building, infrastructure, and one pump (half-capacity) installed initially, and the other pump (other half of capacity) installed 10 years later.

| | Gravity | Pumping |
|---|---|---|
| Initial investment | $2,900,000 | $1,500,000 |
| Investment in $10^{th}$ year | 0 | 400,000 |
| Operation, maintenance, replacements, per year | 10,000 | 25,000 |
| Average annual power cost, | | |
| first 10 years | 0 | 70,000 |
| next 30 years | 0 | 110,000 |
| Average annual benefits | | |
| First 20 years | $220,000 | $220,000 |
| Next 20 years | $390,000 | $390,000 |

Use a 40-year analysis period and 7% interest. Assume no salvage values. Which plan is better, applying the conventional benefit-cost ratio method? Calculate B/C ratios to the hundredths place, and recommend which plan is better.

### Solution:

Since we have a 40-year analysis period, the problem could be solved by any of the exact analysis techniques. Here the problem specifies benefit-cost analysis. Different time periods apply to different cost and benefit elements, so there are several 'n' values:

n=total years, n1=part 1 benefits, n2=part 2 benefits, n3 applies to future investment, n4=part 1 benefits, n5=part 2 benefits.

**Gravity Plan:**

PW of Cost = initial investment + annual O&M (P/A, i%, n)
PW of Benefit = part 1 annual benefits (P/A, i%, n1) + (part 2 annual benefits (P/A, i%, n2)) * (P/F, i%, n1)

PW costs = 2,900,000 + 10,000 (P/A, 7%, 40) = $3,033,317
PW benefits = 220,000 (P/A, 7.5%, 20) + (390,000 (P/A, 7%, 20) * (P/F, 7%, 20) = 3,398,384

B/C Ratio: 1.12

**Pumping Plan:**

PW of Cost = initial investment + future investment (P/F, i%, n3) + annual O&M (P/A, i%, n)
+ part 1 annual power costs (P/A, i%, n4) + part 2 annual power costs (P/A, i%, n5) (P/F,i%, n4)
PW of Benefit = part 1 annual benefits (P/A, i%, n1) + (part 2 annual benefits (P/A, i%, n2)) * (P/F, i%, n1)

PW costs =
1,500,000 + 400,000 (P/F, 7%, 10) + (25,000 (P/A, 7%, 40) + 70,000 (P/A, 7%, 10) + 110,000 (P/A, 7%, 30) (P/F, 7%, 10) = $3,222,177
PW benefits = 220,000 (P/A, 7.5%, 20) + (390,000 (P/A, 7%, 20) * (P/F, 7%, 20) = 3,398,384

B/C Ratio: 1.05

Choose Gravity Option: higher B/C ratio.

### 3. Problem 3

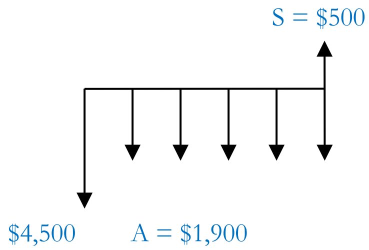
A car dealer is leasing a computer with software for $3,000 a year. As an alternative, she could buy the computer for $4,500 and lease the software for $1,900 a year. Any time she decided to switch to some other computer system, she could cancel the software lease and sell the computer for $500. She decides to buy the computer and lease the software.

(a) What is the payback period? Round to one decimal place (x.x years).
(b) If she kept the computer and software for six years, what would the conventional benefit-cost ratio be, if the interest rate were 10%? Assume the salvage value is treated as a benefit. Round to 2 decimal places.

**Solution:**

Existing lease: A = $3,000/yr

Potential Purchase:




(a) Payback Period
Cost = $4,500.
Salvage value of $500 should be ignored.
Benefit = ($1,900-$3,000 = $1,100)/yr
Payback = ($4,500)/$1,100 = **4.1 years**

(b) Benefit–Cost Ratio
B/C = EUAB/EUAC

If salvage value is assumed to be a benefit:
= [$1,100 + $500 (A/F, 10%, 6)]/[$4,500 (*A*/*P*, 10%, 6)]
= [$1,100 + $500 (0.1296)]/[$4,500 (0.2296)]
= **1.13**

If salvage value is assumed to be a (negative) cost:
= $1,100/[$4,500 (*A*/*P*, 10%, 6) - $500 (A/F, 10%, 6)]
= $1,100/[$4,500 (0.2296) - $500 (0.1296)]
= $1,100 / ($1,033 - $65)
= **1.14**

Either assumption on salvage value is possible: both answers are considered correct.

## 4. Problem 4

A proposed bridge will cost $38 million to build and $1,800,000 per year to maintain. The bridge should last 40 years. Time-saving benefits to the driving public are estimated to be $9,000,000 per year. Damage to adjacent property owners due to ongoing noise is estimated to be worth $2,600,000 per year. It is uncertain what interest rate should be used to evaluate the project: calculate the break-even annual interest rate that results in a B/C ratio of 1. Round your answer to 1 decimal place (x.x%).

**Solution:**

PW(Costs) = $38,000,000 + $1,800,000(*P/A*, *i*, 40)

PW(Benefits) = [$9,000,000 – $2,600,000](*P/A*, *i*, 40) = $6,400,000 (*P/A*, *i*, 40)

B/C = 1 = $6,400,000)(*P/A*, *i*, 40) / ($38,000,000 + $1,800,000(*P/A*, *i*, 40))

Solve for the rate, *i*:

$6,400,000(*P/A*, *i*, 40) = $38,000,000 + $1,800,000(*P/A*, *i*, 40)

(*P/A*, *i*, 40) = $38,000,000 / $4,600,000 = 8.2609

By interpolation, ***i* = 12.0%**

5. **Problem 5**

If a net present worth analysis for a stream restoration plan indicates that the net present worth (NPW) is greater than zero, does that guarantee that the plan is the best possible (optimal) solution? Why or why not? You may wish to use a graph in your explanation, but do not need to.

**Solution:**

NPW>0 means TB>TC, so it's a good project. But that doesn't guarantee that it will maximum total net benefits.

That tells us if the plan is better than no action. Many plans can have NPV>0, but only one plan will have maximum net benefits (which occurs when MB=MC).