CE 5366 – Water Resources Management Exercise Set 3

Purpose: Practice engineering economic mathematics

Exercise

1. Two mutually exclusive project alternatives that provide identical service are described below:

Project ID	Initial Cost	Annual O&M	Salvage Value	Lifespan
A	$10,000	$2,000	$1,000	10
B	$25,000	$1,500	$5,000	20

Assuming a discount rate of 5%

a) Which alternative has the lower annual cost?

b) What is the incremental annual cost of going from the less to the more expensive alternative?

c) Select the best alternative by the present-worth method.

d) What is the rate of return on the incremental investment of B?

e) What initial cost of replacing A after 10 years would make the two alternatives equivalent, assuming none of the other costs change?

Example R Script

An example in **R** is below.[1]

```r
# cash flow calculations for ES3
rm(list=ls())
discount_rate <- 0.05 # 3% interest rate
# option A
# compute present values of expenses first 10 years
initial_costA <- 10000
operationsA <- rep(2000,10)
salvageA <- 1000
### compute the PV of the operations cost
present_value <- numeric(0)
present_value <- 0
for (i in 1:10){ #find present value of the i-th year payment
  present_value[i] <- operationsA[i]*(1+discount_rate)^(-i)
}
operationsAPV <- sum(present_value)
### compute the PV of the salvage payment
salvageAPV <- salvageA*(1+discount_rate)^(-10)
#print(cbind(initial_costA,operationsAPV,salvageAPV))
# now compute the PV for the second 10 years
presentValueA1 <- initial_costA+operationsAPV+salvageAPV
presentValueA2 <- presentValueA1*(1+discount_rate)^(-10)
presentValueA <- presentValueA1+presentValueA2
message("Present Value A = $",presentValueA)
########## Alternative B ################
initial_costB <- 25000
operationsB <- rep(1500,20)
salvageB <- 5000
### compute the PV of the operations cost
present_value <- numeric(0)
present_value <- 0
for (i in 1:20){ #find present value of the i-th year payment
  present_value[i] <- operationsB[i]*(1+discount_rate)^(-i)
}
operationsBPV <- sum(present_value)
```

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[1]You could use it as-is, if you have **R** installed; or easily convert into Python. The exercise itself is simple enough to complete in Excel (or LibreOffice Spreadsheet, or Apple Numbers) choose your favorite poison here!

```
### compute the PV of the salvage payment
salvageBPV <- salvageB*(1+discount_rate)^(-20)
#print(cbind(initial_costB,operationsBPV,salvageBPV))
presentValueB <- initial_costB+operationsBPV+salvageBPV
message("Present Value B = $",presentValueB)
# now convert both to annual costs
### compute the PV of the operations cost
present_valueA <- numeric(0)
present_valueA <- 0
### compute the PV of the operations cost
present_valueB <- numeric(0)
present_valueB <- 0
## read in guess for annual cost
  avA <- readline(prompt="Enter annual cost for alternative A: ")
  avA <- as.numeric(avA)
  avB <- readline(prompt="Enter annual cost for alternative B: ")
  avB <- as.numeric(avB)
#avA <- 3374.55
#avB <- 3657.28
annualA <- rep(avA,20)
annualB <- rep(avB,20)
for (i in 1:20){ #find present value of the i-th year payment
  present_valueA[i] <- annualA[i]*(1+discount_rate)^(-i)
  present_valueB[i] <- annualB[i]*(1+discount_rate)^(-i)
}
message("annual cost A = $",avA," PVA = $",sum(present_valueA)," PValue A = $",presentVa
message("annual cost B = $",avB," PVB = $",sum(present_valueB)," PValue B = $",presentVa
```