Carleton University
Department of Civil and Environmental Engineering
Engineering Economics (ECOR 3800B)
ASSIGNMENT # 2

Issued March 08, 2016 Due Date: March 17, 2016 at 6:00 PM

Drop off location: Filing cabinet near the entrance to the Civil and Environmental Engineering office.
The cabinet located to the right of room 3424 ME.

Question 1

(a)
One thousand dollars is invested for seven months at an interest rate of 1% per month. What is the nominal interest rate? What is the effective interest rate?

Solution
i = 1%/month
Effective Interest Rate = $(1 + i)^m - 1 = (1.01)^{12} - 1$
$= 0.127 = 12.7\%$

(b)
A firm charges its credit customers interest 1.75% a month. What is the effective interest rate?

Effective Interest Rate = $(1 + 0.0175)^{12} - 1 = 0.2314 = 23.14\%$

(c)
If the nominal annual interest rate is 12% compounded quarterly, what is the effective annual interest rate?

Effective Interest Rate = $(1 + i)^m - 1 = (1.03)^4 - 1 = 0.1255 = 12.55\%$

(d)
A local store, for its charge accounts, charges 1.5% each month on the unpaid balance. What nominal annual interest rate is being charged? What is the effective interest rate?

Nominal Interest Rate = 12 (1.5%) = 18%
Effective Interest Rate = $(1 + 0.015)^{12} = 0.1956 = 19.56\%$

(e)
What interest rate, compounded quarterly, is equivalent to a 9.31% effective interest rate?

Effective Interest Rate = $(1 + i)^m - 1$
$0.0931 = (1 + i)^4 - 1$
$1.0931 = (1 + i)^4$
$1.0931^{0.25} = (1 + i)$
$1.0225 = (1 + i)$
$i = 0.0225$
$= 2.25\%$ per quarter
$= 9\%$ per year

(f)
A bank advertises it pays 7% annual interest, compounded daily, on savings accounts, provided the money is left in the account for four years. What effective annual interest rate do they pay?

Effective Interest Rate = $(1 + i)^m - 1 = (1 + (0.07/365))^{365} - 1$
$= 0.0725 = 7.25\%$

(g)
At the Central Furniture Company, customers who buy on credit pay an effective annual interest rate of 16.1%, based on monthly compounding. What is the nominal annual interest rate that they pay?

Effective interest rate = $(1 + i)^m - 1 =$
$1.61 = (1 + i)^{12}$
$(1 + i) = 1.61^{0.0833} = 1.0125$
$i = .0125 = 1.25\%$

(h)
A student bought a $75 used guitar and agreed to pay for it with a single $85 payment at the end of six months. Assuming semi-annual (every six months) compounding, what is the nominal annual interest rate? What is the effective interest rate?

$F = P (1 + i)^n$
$\$85 = \$75 (1 + i)^1$
$(1 + i) = \$85/\$75 = 1.133$
$i = 0.133 = 13.3\%$
Nominal Interest Rate = $13.3\% (2) = 26.6\%$
Effective Interest Rate = $(1 + 0.133)^2 - 1 = 0.284 = 28.4\%$

(i)
Jim Duggan made an investment of $10,000 in a savings account 10 years ago. This account paid interest of 5.5% for the first four years and 6.5% interest for the remaining six years. The interest charges were compounded quarterly. How much is this investment worth now?

Interest rate for the first 4 years = 5.50% nominal, compounded 4 times per year
Interest rate for the next 6 years = 6.50% nominal, compounded 4 times per year
Principal = $10,000
The two multiplying factors are $(1 + 5.5\%/4)^4 \times 4$ and $(1 + 6.5\%/4)^6 \times 4$
The factors are 1.2442 and 1.4724
Thus, F = $18,319.23

(j)
Traffic at a certain intersection is currently 2,000 cars a day. A consultant has told the city that traffic is expected to grow at a continuous rate of 5% a year for the next four years. How much traffic will be expected at the end of two years?

P = 2000 cars/day,
n = 2, i = 5%, F2 = ? cars/day

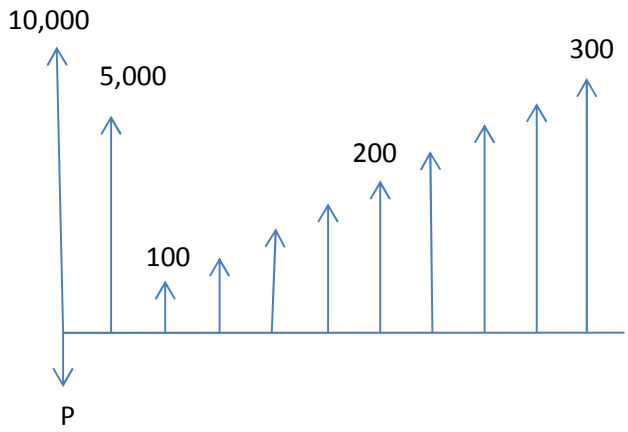
$F2 = P\, e^{in} = 2000\, e^{(0.05)(2)} = 2{,}210$ cars/day

Question2

A company expects to install smog control equipment on the exhaust of a gasoline engine. The local smog control district has agreed to pay to the firm a lump sum of money to provide for the first cost of the equipment and maintenance during its 10-year useful life. At the end of 10 years the equipment, which initially cost $10,000, is valueless. The company and smog control district have agreed that the following are reasonable estimates of the end-of-year maintenance costs:

Year	Maintenance Cost ($)	Year	Maintenance Cost ($)
1	500	6	200
2	100	7	225
3	125	8	250
4	150	9	275
5	175	10	300

Assuming interest at 6% a year, how much should the smog control district pay to the company now to provide for the first cost of the equipment and its maintenance for 10 years?

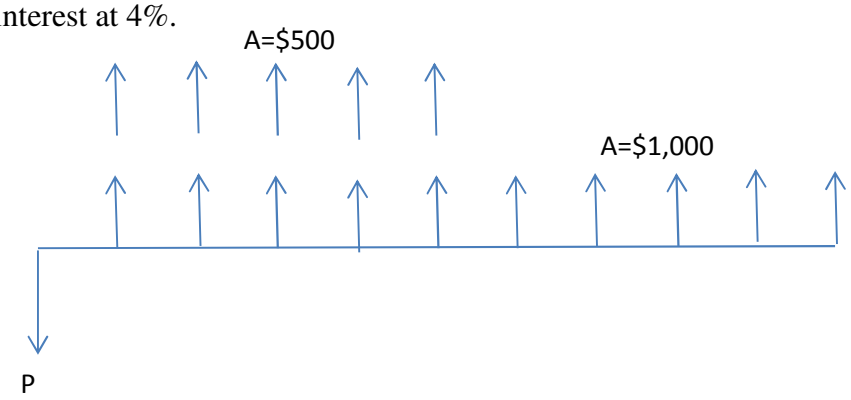


P = 10,000+500(P/F,6%,1)+100(P/A,6%,9)(P/F,6%,1)+25(P/G,6%,9)(P/F,6%,1)
=10000+500(0.9434)+100(6.802)(0.9434)+25(24.577)(0.9434

=$11693.05

Question 3

Annual maintenance costs for a particular section of highway pavement are $2,000. The placement of a new surface would reduce the annual maintenance cost to $500 a year for the first five years and to $1,000 a year for the next five years. After 10 years the annual maintenance would again be $2,000. If maintenance costs are the only saving, what investment can be justified for the new surface? Assume interest at 4%.



Maximum investment = Present Worth of Benefits

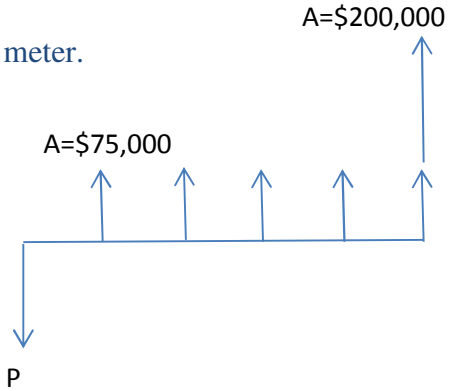
=1,000 (P/A, 4%, 10) + 500 (P/A, 4%, 5)

=1,000(8.111) + 500 (4.452)

= $10,337

Question 4

A road-building contractor has received a major highway construction contract that will require 50,000 m^3 of crushed stone each year for five years. The stone can be obtained from a quarry for $5.80/$m^3$. As an alternative, the contractor has decided to try to buy the quarry. He believes that if he owned the quarry, the stone would cost him only $4.30/$m^3$. He thinks he could resell the quarry at the end of five years for $200,000. If the contractor uses a 10% interest rate, how much would he be willing to pay for the quarry?



Buying the quarry will save the contractor $5.80 – 4.30 = $1.50 per cubic meter.
This represents an annual saving of
A = $50,000 × 1.50 = $75,000.
At i = 10% and n = 5 years, the present worth of these savings will be

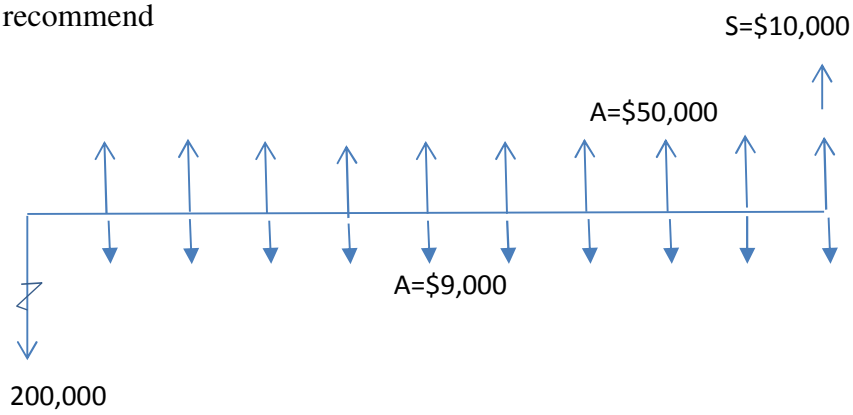
P = $75,000(P/A, 10%, 5) = $75,000(3.791) = $284,325

And he will also get its salvage value at Year 5 = $200,000,
which again can be converted to a present worth by the P/F formula:

P = $200,000(P/F, 10%, 5) = $200,000(0.6209) = $124,180 So the break-even point occurs when the quarry price is just equal to the present value of these savings:
So,
Q = $284,325 + $124,180
= $408,505
The contractor would be willing to pay $408,505 for the quarry.

Question 5

IBP Inc. is considering establishing a new machine to automate a meat-packing process. The machine will save $50,000 in labour annually. The machine can be bought for $200,000 today and will be used for 10 years. It has a salvage value of $10,000 at the end of its useful life. The new machine will require an annual maintenance cost of $9,000. The corporation has a minimum rate of return of 10%. Do you recommend automating the process?



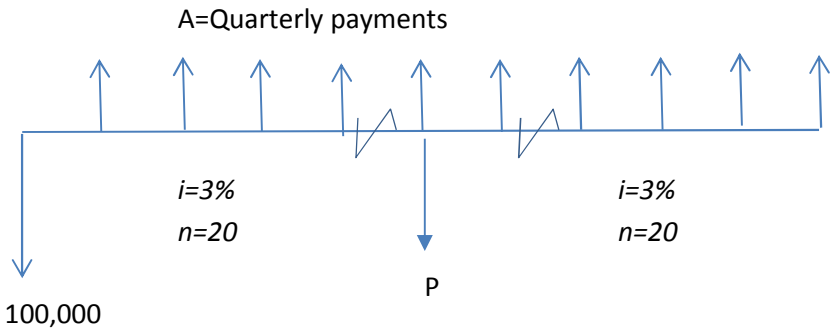
The objective is to determine if the Net Present Worth is non-negative.
NPW of Benefits = $50,000 ($P/A$, 10%, 10) + $10,000 ($P/F$, 10%, 10)
= $50,000 (6.145) + $10,000 (0.3855)
= $311,105
PW of Costs = $200,000 + $9,000 ($P/A$, 10%, 10)
= $200,000 + $9,000 (6.145)
= $255,305
NPW = $311,105 – $255,305
= $55,800
Since NPW is positive, the process should be automated.

Question 6

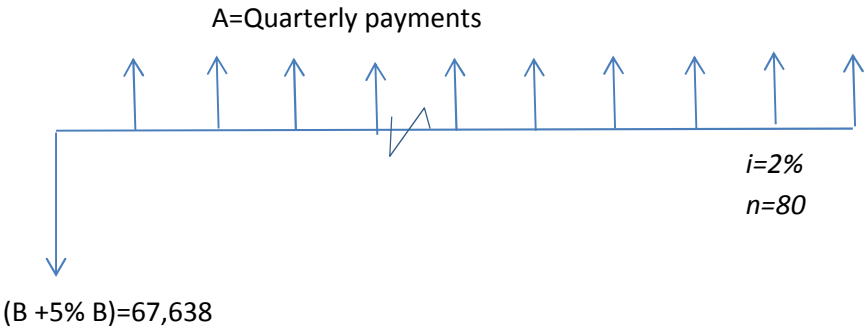
A new office building was constructed five years ago by a consulting engineering firm. At that time the firm obtained a bank loan for $100,000 with a 12% annual interest rate, compounded quarterly. The loan is to be repaid in 10 years by equal quarterly payments. The loan can also be repaid at any time without penalty.

As a result of internal changes in the firm, it is now proposed to refinance the loan through an insurance company. The new loan would be for a 20-year term with an interest rate of 8% a year, compounded quarterly. The new equal quarterly payments would repay the loan in the 20-year period. The insurance company requires the payment of a 5% loan initiation charge (often described as a "five-point loan fee"), which will be added to the new loan.

(a) What is the balance due on the original mortgage if 20 payments have been made in the last five years?



$A = \$100{,}000\ (A/P, 3\%, 40) = \$100{,}000\ (0.0433) = \$4{,}330$
$P = \$4{,}330\ (P/A, 3\%, 20) = \$4{,}330\ (14.877) = \$64{,}417$



(b) What is the difference between the equal quarterly payments on the present bank loan and the proposed insurance company loan?

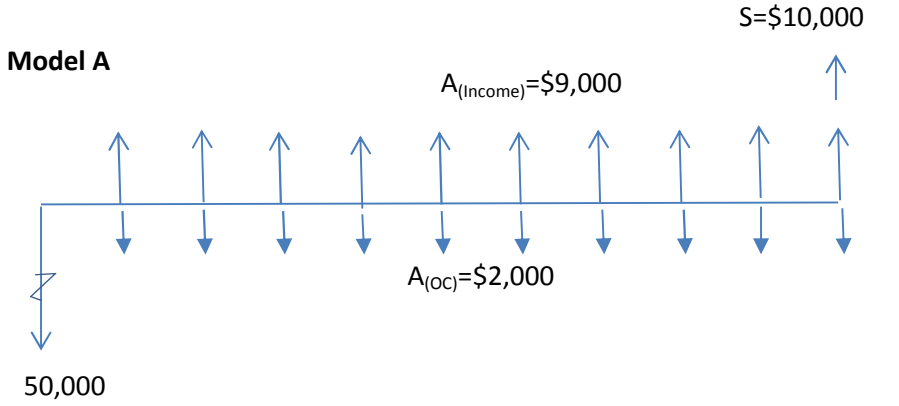
Service Charge = 0.05 P
Amount of new loan= 1.05 ($64,417) = $67,638
Quarterly Payment on new loan = $67,638 $(A/P, 2\%, 80)$
= $67,638 (0.0252)
= $1,704
Difference in quarterly payments = $4,330 – $1,704 = $2,626

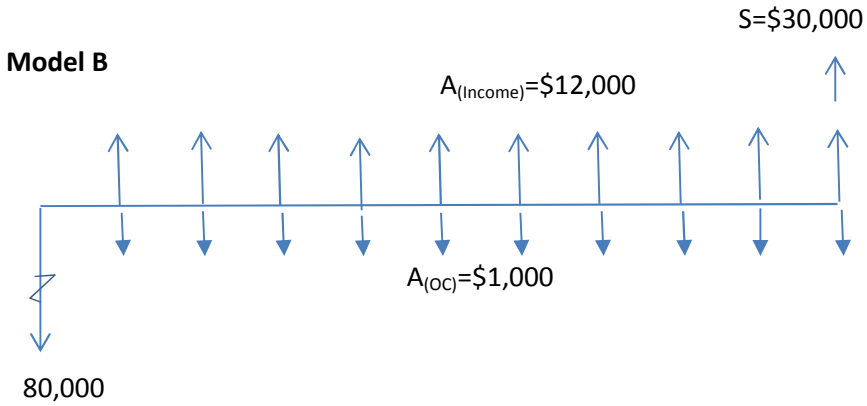
Question 7

Walt Wallace Construction Enterprises is investigating the purchase of a new dump truck. Interest is 9%. The cash flows for two likely models are as follows:

Model	First Cost ($)	Annual Operating Cost ($)	Annual Income ($)	Salvage Value ($)	Life
A	**50,000**	**2,000**	**9,000**	**10,000**	**10 years**
B	**80,000**	**1,000**	**12,000**	**30,000**	**10 years**

(a) Using present worth analysis, decide which truck the firm should buy, and explain why.
(b) Before the construction company can close the deal, the dealer sells out of Model B and cannot get any more. What should the firm do now and why?





NPWA = –$50,000 – $2,000 (*P*/*A*, 9%, 10) + $9,000 (*P*/*A*, 9%, 10) + $10,000 (*P*/*F*, 9%, 10)
= –$50,000 – $2,000 (6.418) + $9,000 (6.418) + $10,000 (0.4224)
= –$850
NPWB = –$80,000 – $1,000 (P/A, 9%, 10) + $12,000 (P/A, 9%, 10) + $30,000 (P/F, 9%, 10)
= –$80,000 – $1,000 (6.418) + $12,000 (6.418) + $30,000 (0.4224)
= +$3,270

a) Buy Model B because it has a positive NPW.

b) Select null option. The NPW of Model A is negative therefore it is better to do nothing or look for more alternatives.