IEGR 350: Engineering Economy
Spring 2016
M. Salimian **Your Name:**

Test 2 (100 Points)

Time: 100 Minutes (+ 10 if you had roll-over minutes)

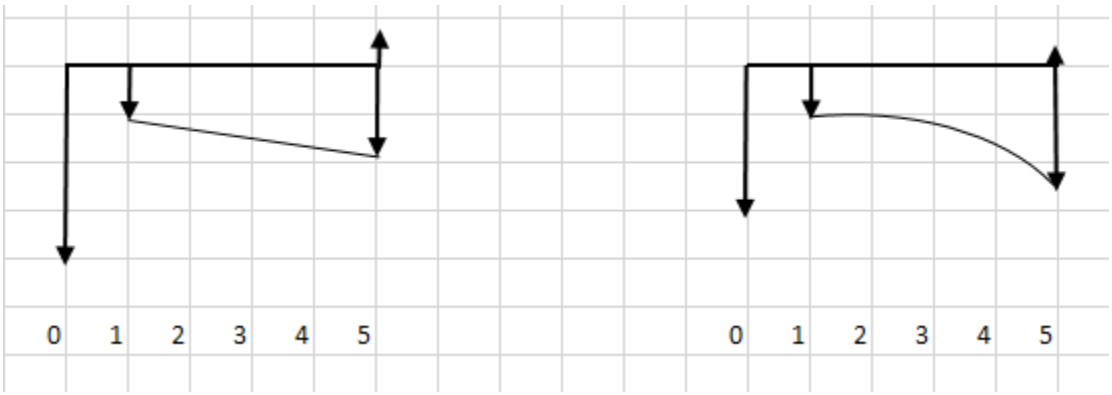
Read instructions carefully. Explain and show your work. No use of computer or cell phone allowed. Use of printed formula sheet and table for 8%, 12% and 15% is allowed. Non-digital textbook for use of the 3 tables (not the formula) is allowed. Write your name on sheets of paper you have (including table and formula sheets) and turn them in at the end of the test time.

Use of EXCEL: There are 2 computers assigned to be used with EXCEL for rate of return calculation only. Any Internet access attempt or use of EXCEL for problems not eligible for spreadsheet use would cause in immediate disqualification and a grade of zero on overall test. Use of the computer is limited to 5 minutes per person at a time. No file should be saved, only the results copied. EXCEL should be closed after the use and launched by the next user. You must have the cash flow that you are planning to enter ready and show it to the instructor before you are allowed to use the spreadsheet.

PROBLEM 1:

Determine which of the following two machines will have the lower (a) capital recovery and (b) equivalent annual total cost.
Machine A has a first cost of $80,000 and an operating cost of $21,000 in year 1, increasing by $500 per year through year 5, after which time it will have a salvage value of $13,000. Machine 2 has a first cost of $62,000 and an operating cost of $21,000 in year 1, increasing by 8% per year through year 5, after which time it will have a scavenge value of $2000. Utilize an interest rate of 12% per year compounded monthly to determine both estimates. (25 pts) (No use of EXCEL)

Solution: This is problem 22 from Chapter 6 of the textbook (with a change in interest rate) whose solution had been available on the course Web site.



Since, interest rate given as 12% per year is being compounded monthly, we need to find the effective interest rate.

Effective Interest rate calculation:
Nominal: 12%, (MC) monthly compounding
$r = (1 + i/n)^n - 1 = (1+0.12/12)^{12} - 1 =$
$1.01268 - 1 = 0.1268$ or 12.68%

We can now calculate the capital recovery. Remember that capital recovery finds the annual payments that will be equivalent to the initial capital with consideration for salvage value if there is any.

Part (a)
To calculate capital recovery we need to find what the annual equivalent payments are for the capital expenditure and also considering the salvage value.
$CR_{Machine\ A}$ = - 80000 (A/P, 12.68%, 5) + 13000 (A/F, 12.68%, 5)
$CR_{Machine\ A}$ = - 80000 (0.2821) + 13000 (0.1553) = $-20,549.10 per year
$CR_{Machine\ B}$ = - 62000 (A/P, 12.68%, 5) + 2000 (A/F, 12.68%, 5)
$CR_{Machine\ B}$ = - 62000 (0. 2821) + 2000 (0.1553) = $-17,179.60 per year
Difference = 20549.10 - 17,179.60 = $3,369.50 per year lower CR with Machine B.

Part (b)
$AW_{Machine\ A}$ = -80000(A/P, 12.68%, 5)-[21000 +500(A/G, 12.68%, 5)]+13000(A/F, 12.68%, 5)
$AW_{Machine\ A}$ = - 80000 (0.2821) - [21000 + 500 (1.7627)] + 13000 (0.1553) = $-42430.45

For Machine B we need to calculate present worth of the cash flow, then convert it to equal annual values.
$PW_{Machine\ B} = -62000 - 21000 \{ 1 - [(1+ g)/(1+ i)]^5 \} / (i - g) + 2000 (P/F, 12.68\%, 5)$
$PW_{Machine\ B} = -62000 - 21000 \{ 1 - [(1+ 0.08)/(1+0.1268)]^5 \} / (0.1268-0.08) + 2000 (0.5505)$
$= - 146657.57$
$AW_{Machine\ B}$ = - 146657.57 (A/P, 12.68%, 5) = - 146657.57 (0.2821) = $-41,372.10
Therefore, Machine B has a slightly smaller annual cost ($1,058.35)

PROBLEM 2:

Five years ago, Nagrom Etats issued $20 million worth of 12% 30-year bonds with the dividend payable bi-monthly. The bonds have a call date of this year if Nagrom Etats decides to take advantage of it. The interest rate in the marketplace decreased enough that the company is considering calling the bonds since the

coupon rate is relatively high. If the company buys the bonds back now for $21.5 million, determine the rate of return that the company will make (a) per quarter and (b) per year (nominal). (20 pts) (EXCEL eligible)

Solution: This is problem 56 from Chapter 7 of the textbook (with a slight modification) whose solution had been available on the Web site.

The "call" option means that by spending $21.5 million now, the company will not have to make the bi-monthly bond dividend payments and pay the face value of the bonds when they come due 25 years from now. First we need to calculate the dividends. They are paid 6 times per year.

I = Vb/c = 20,000,000 (0.12) / 6 = $400,000

So, by spending $21.5 million now, the company will save $400,000 every two months. For 25 years and will save another $20 million 25 years from now. Note that our periods are two months, which makes 6(25) = 150 total periods for the 25 years. The ROR relation is:

0 = -21,500,000 + 400,000 (P/A, i%, 150) + 20,000,000 (P/F, i%, 150)
Using EXCEL we will get 1.85% per every two months.

The rates are requested to be given per quarter and per year. Problem explicitly states that you need to find the nominal rates per quarter and per year, so for the quarter year we can calculate the rate to be 2*1.85 = 3.7% and for the year 6*1.85 = 11.1%.

PROBLEM 3:
Use the modified rate of return approach with an investment rate of 15% per year and a borrowing rate of 8% to find the external rate of return for the following cash flows.

Year	0	1	2	3
Net Cash Flow ($)	+16,000	-32,000	-25,000	+70,000.

(25 pts) (No use of EXCEL)

Solution: This is problem 38 from Chapter 7 of the textbook (with a different interest rates) whose solution had been available on the Web site.

Follow the steps of modified ROR procedure.

PW_0=-32000(P/F,8%,1)-25000(P/F,8%,2) =-32000(0.9259)-25000(0.8573)
PW_0=$-51,061.30

FW_3=16000(F/P,15%,3) +70000 = 16000(1.5209) +70000 = $94,334.40

94334.40 = 51061.30 (F/P, i, 3)
(F/P, i, 3) = $(1+i)^3$ = 94334.40 / 51061.30 = 1.8475

Solving for i

i = $(1.8475)^{(1/3)}$ -1 = 1.227 – 1 =0.227 or 22.7% per year

PROBLEM 4:

Five revenue projects are under consideration by General Dynamics for improving material flow through an assembly line. The initial cost in $1000 and the life of each project are as follows (revenue estimates are not shown):

	PROJECT				
	A	B	C	D	E
Initial Cost ($1000)	-700	-2300	-900	-300	-1600
Life (Years)	5	8	5	5	6

An engineer made the comparisons shown below. From the calculations, determine which project, if any, should be undertaken if the company's MARR is (a) 11.5% per year and (b) 13.5% per year. If other calculations are necessary to make a decision, state which ones. (30 pts) (EXCEL eligible)

Comparison	Incremental Rate of Return, %
B vs DN	13%
A vs B	19%
D vs DN	11%
E vs B	15%
E vs D	24%
E vs A	21%
C vs DN	7%
C vs A	19%
E vs DN	12%
A vs DN	10%
E vs C	33%
D vs C	33%
D vs B	29%

Solution: This is problem 32 from Chapter 8 of the textbook.

Since problem states that, "determine which project, if any, should be undertaken" then it is clear that DN alternative is also available. That is why some comparisons in the problem are taken with DN alternative. We begin by ranking alternatives (including DN) according to increasing initial investment and compare them incrementally.

Rank: DN (0), D (300), A (700), C (900), E (1600), B (2300)

Case (a) MARR=11.5%

DN is the Defender and D is the Challenger.
According to the list D vs DN yields Δi = 11% which is less than MARR. Eliminate D.

Alternative A is the next challenger.
A vs DN yields Δi = 10% which is smaller than MARR. Eliminate A.

Alternative C is the next challenger.
C vs DN yields Δi = 7% which is smaller than MARR. Eliminate C.

Alternative E is the next challenger.
E vs DN yields Δi = 12% which is larger than MARR. Eliminate DN.

E is the new Defender. Alternative B is the challenger.
B vs E yields Δi = 15% which is larger than MARR. Eliminate E.

No more, challenger. Therefore, select B.

Case (b) MARR=13.5%

DN is the Defender and D is the Challenger.
According to the list D vs DN yields Δi = 11% which is less than MARR. Eliminate D.

Alternative A is the next challenger.
A vs DN yields Δi = 10% which is smaller than MARR. Eliminate A.

Alternative C is the next challenger.
C vs DN yields Δi = 7% which is smaller than MARR. Eliminate C.

Alternative E is the next challenger.
E vs DN yields Δi = 12% which is smaller than MARR. Eliminate E.

Alternative B is the challenger.
B vs DN yields Δi = 13% which is smaller than MARR. Eliminate B.

No more, challenger. Therefore, select DN.