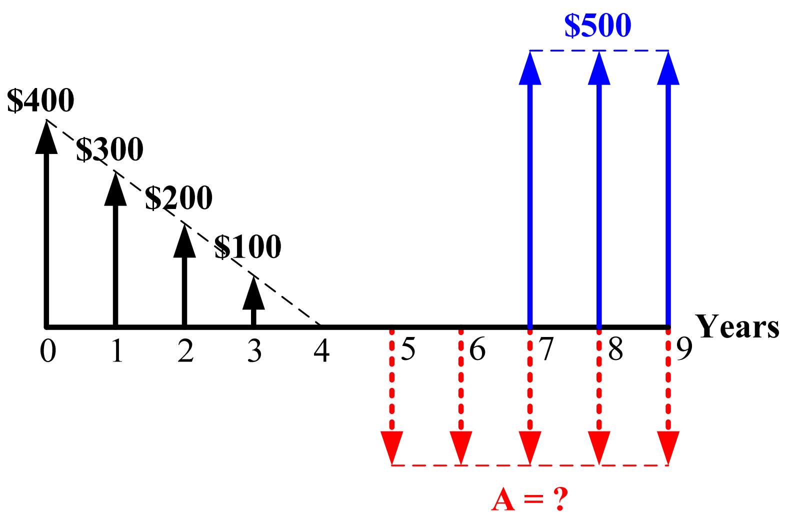
Final Examination - KEY

COURSE : INE 320, Engineering Economy I
DATE : Monday, May 31, 2010
TIME : 8:00 – 10:00 a.m.
SEMESTER : Spring 2010
PROFESSOR : Dr. Raymond Ghajar

1.	Your client must make a lump sum payment of $150,000 at the end of 10 years. To accumulate the necessary sum, the client plans to make a series of 40 equal quarterly deposits into an account earning an interest of 1% per month. The first deposit is made now. Find the amount that needs to be deposited each quarter.	**P**
1.	Deposits are quarterly, so the effective interest rate per quarter. $i_q = (1+i_m)^3 - 1 = (1+0.01)^3 - 1 = \underline{3.0301\%}$ Forty quarterly deposits starting now are equivalent to a future amount of $150,000 at the end of 10 years using the following equation: A(F/A, 3.0301%, 40)(F/P, 3.0301%, 1) = $150,000 A(75.9179)(1.0303) = $150,000 ⇒ A= $150,000/78.2182 = **$1,917.71**	**S**
2.	Find the value of A in the cash flow diagram shown below to establish equivalence of cash inflows and outflows. Let *i* = 12% per year. Use one linear gradient series factor in your solution.  	**P**
2.	Economic equivalence is established at EOY9 as follows: [$400(P/A, 12%, 4) – $100(P/G, 12%, 4)](F/P, 12%, 10) + $500(F/A, 12%, 3) = A(F/A, 12%, 5) [$400(3.0373) – $100(4.1273)](3.1058) + $500(3.3744) = A(6.3528) Solving for A gives $A = \dfrac{\$4{,}178.74}{6.3528} = \underline{\underline{\$657.78}}$	**S**

3. A city that is attempting to attract a professional football team is planning to build a new football stadium costing $12 million. Annual upkeep is expected to amount to $25,000 per year. In addition, the artificial turf will have to be replaced every ten years at a cost of $150,000. Painting every five years will cost $65,000. If the city expects to maintain the facility indefinitely, what will be its equivalent uniform annual cost using an interest rate of 6%? **P**

3. The effective interest rate for the 5 year period is $i_5 = [1+0.06]^5 - 1 = 33.82\%$ **S**

The effective interest rate for the 10-year period is $i_{10} = [1+0.06]^{10} - 1 = 79.08\%$

The Capital Equivalent of the turf is: $CE(79.08\%)_{turf} = \dfrac{\$150{,}000}{0.7908} = \$189{,}669.90$

The CE of the painting is: $CE(33.82\%)_{Painting} = \dfrac{\$65{,}000}{0.3382} = \$192{,}179.43$

The total annual equivalent uniform cost of the football stadium is:

$A = A_{upkeep} + i*[I + CE_{turf} + CE_{painting}]$

A = $25,000 + 0.06*[$12,000,000 + $189,669.90 + $192,179.43] = **$767,910.96**

4. Annual expenses for two alternatives have been estimated as shown below. If the average general inflation rate is 6% per year and the real interest rate is 9% per year, select the best alternative using the net present worth analysis. **P**

End of year	Alternative A (Actual $)	Alternative B (Constant $)
1	-120,000	-100,000
2	-132,000	-110,000
3	-148,000	-120,000
4	-160,000	-130,000

4. **Alternative A** **S**

The analysis can be done in constant or actual dollars as shown in the table. The PW will be the same regardless of which method is used.

$\bar{f} = 6\%$ and $i' = 9\% \rightarrow i = i' + \bar{f} + i'\bar{f} = 0.06 + 0.09 + 0.06 \times 0.09 = 15.54\%$

n	A_n	$A'_n = A_n(P/F, \bar{f}, n)$
1	-$120,000	-$113,207.55
2	-$132,000	-$117,479.53
3	-$148,000	-$124,263.65
4	-$160,000	-$126,734.99
i(%)	15.54%	9%
NPW	**-$388,476.91**	**-$388,476.91**

Alternative B

Here too, we can calculate the NPW using constant and actual dollars.

n	B'$_n$	$B_n = B'_n(F/P, \bar{f}, n)$
1	-100,000	-106,000.00
2	-110,000	-123,596.00
3	-120,000	-142,921.92
4	-130,000	-164,122.00
i(%)	9%	15.54%
NPW	**-$369,085.21**	**-$369,085.21**

$NPW_B > NPW_A \Rightarrow$ **Select Alternative B**.

N.B. Alternative B is a linear gradient series, so

$NPW(9\%)_B$ = -$100,000(P/A, 9%, 4) – $10,000(P/G, 9%, 4)

$NPW(9\%)_B$ = -$100,000(3.2397) – $10,000(4.5113) = **-$369,085.21**

5.	A company involved in environmental restoration maintained a contingency fund of $10 million. The company kept the money in a stock market fund, which earned 16% per year. The inflation rate during the 5-year period the company had the money invested was 5% per year. (a) How much money did the company have at the end of the 5-year period? (b) What was the buying power of the money in terms of dollars when the investment was originally made? (c) What was the company's real rate of return on the investment?	**P**

5. P = $10,000,000 i = 16% /yr $\bar{f}$ = 5% /yr for 5 years **S**

(a) The amount of money available at EOY5 is:

$F = P(1 + i)^5$ = $10,000,000$(1.16)^5$ = **$21,003,416.58**

(b) The true buying power of the investment is calculated using the inflation-free interest rate.

$$i' = \frac{i - \bar{f}}{1 + \bar{f}} = \frac{0.16 - 0.05}{1 + 0.05} = \underline{10.476\%}$$

F' = $10,000,000$(1 + 0.10476)^5$ = **$16,456,726.47**

(c) The real ROR on the investment is the inflation-free interest rate.

i' = 10.476%

6.	The engineer at the Smoke Ring Cigar Company wants to do a Rate-of-Return analysis for two wrapping machines. The details below are available but the engineer does not know what value to use for a MARR since some projects at the company are evaluated at 5% and some at 6%.	**P**

Cost items	Machine A	Machine B
First cost ($)	10,000	9,000
Annual labor cost ($/yr)	5,000	5,000
Annual O&M cost ($/yr)	300	500
Salvage value ($)	1,000	1,000
Useful life (years)	6	6

Calculate the Internal Rate of Return of the incremental investment and determine whether the difference in MARR values would change the decision concerning which machine to buy.

6. Since both machines have equal lives, the incremental cash flow is given by: **S**

Cost items	A - B
First cost	1,000
Annual costs	-200
Salvage value	0

The breakeven interest rate must satisfy the following equation:

$NPW(i^*)_{A-B} = -\$1,000 + \$200(P/A, i^*, 6) = 0$

By linear interpolation, the value of i* is found as shown below:

Action	i(%)	$NPW_{A-B}(i\%)$
Initial value	5	\$15.1384
Increase i	6	-\$16.5351
Interpolate	**5.478**	-\$0.19529

$NPW_{A-B}(5.478\%) \approx 0 \Rightarrow$ **i* = IRR = 5.478%**

If **MARR = 5%** $\Rightarrow$ IRR > MARR $\Rightarrow$ **Choose A**

If **MARR = 6%** $\Rightarrow$ IRR < MARR $\Rightarrow$ **Choose B**

So the difference in MARR does have an impact on the decision concerning which machine to buy.

7. Two years ago the annual inflation rate was 12% and the annual interest rate was 20%. Last year these rates were 8% and 13%, respectively. Find the inflation-free rates for each of the last 2 years and then find the average value over that 2-year period. **P**

7. The inflation market interest rates for the last two years are given by: **S**

$\overline{f_{-2}} = 12\%$, $\overline{f_{-1}} = 8\%$, $i_{-2} = 20\%$ and $i_{-1} = 13\%$

The inflation-free interest rate for the last two years is calculated as follows:

$$i'_{-2} = \frac{i_{-2} - \overline{f_{-2}}}{1 + \overline{f_{-2}}} = \frac{0.2 - 0.12}{1 + 0.12} = \underline{\underline{7.1429\%}}\ ;\ i'_{-1} = \frac{i_{-1} - \overline{f_{-1}}}{1 + \overline{f_{-1}}} = \frac{0.13 - 0.08}{1 + 0.08} = \underline{\underline{4.6296\%}}$$

The average inflation-free interest rate for the 2-year period is:

$$\left(1 + \overline{i'}\right)^2 = \left(1 + i'_{-1}\right)\left(1 + i'_{-2}\right)$$

$$\overline{i'} = \sqrt{\left(1 + i'_{-1}\right)\left(1 + i'_{-2}\right)} - 1 = \sqrt{\left(1 + 0.046296\right)\left(1 + 0.071429\right)} - 1 = \underline{\underline{5.8788\%}}$$

8. An automatic block-making machine is available for $50,000. Your best estimates indicate that it will be worth $10,000 when you expect to dispose of it at the end of five years. It is capable of producing 100,000 blocks per year at a net profit before taxes of $0.20 per block. **P**

Find the annual cash flow after taxes for the machine using the double declining balance depreciation method. Use a 28% tax rate.

8. The DDB depreciation schedule is given by: **S**

n	B_{n-1}	$D(DDB)_n$	$D(SL)_n$	B_n	Decision
1	$50,000	$20,000	$8,000	$30,000	No switch
2	$30,000	$12,000	$5,000	$18,000	No switch
3	$18,000	$7,200	$2,666.67	$10,800	No switch
4	$10,800	$800	$400	$10,000	Stop
5	$10,000	-	-	$10,000	Stop

The cash flow is calculated in the following table as follows:

Taxable Income = Profit – Depreciation

Income Tax = Tax rate * Taxable Income

Net Income = Taxable Income – Income Tax

Cash Flow = Net Income + Depreciation

n	Profit	$D(DDB)_n$	Taxable income	Income tax	Net income	Cash flow
1	$20,000	$20,000	-	-	-	$20,000
2	$20,000	$12,000	$8,000	$2,240	$5,760	$17,760
3	$20,000	$7,200	$12,800	$3,584	$9,216	$16,416
4	$20,000	$800	$19,200	$5,376	$13,824	$14,624
5	$20,000	-	$20,000	$5,600	$14,400	$14,400