CHE374 – Engineering Economic Analysis
Midterm Test, October 22, 2008

Name: SOLUTIONS

Student Number:

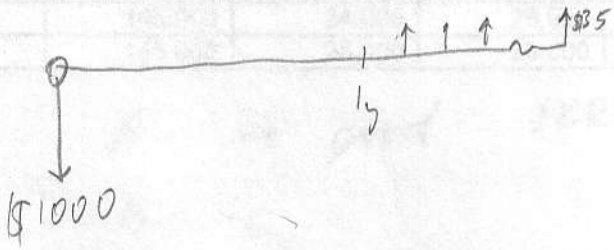
Question Number	Marks
1	5
2	5
3	16
4	6
5	5
6	8
Total	**45**

Answer all questions. Please write your final answer in pen.

Aids allowed: Calculator, textbook, class notes, personal notes.

Question #1 (5 marks)

A chair at a furniture store has a price of $1000. The advertisement reads "Don't pay a cent for the first year, then pay just $35 in 48 easy monthly instalments". Assume the first payment is due at the end of the first month, one year from date of purchase. What is the IRR based on the financing provided by the store. Express your answer as an annual rate based on annual compounding.



$$1000 = (P/F, i, 12) \times 35 \times (P/F, i, 48)$$ (2)

try $i = 1\%$

RHS = 1179.5

try $i = 2\%$

RHS = 846.49

interpolate:

$$\frac{i - i_1}{i_2 - i_1} = \frac{R - R_1}{R_2 - R_1}$$

$$i = i_1 + \frac{R - R_1}{R_2 - R_1}(i_2 - i_1)$$

$$= 1\% + \frac{1000 - 1179.5}{846.49 - 1179.5}$$

$$= 0.01539$$ (2)

∴ annual rate, annual comp:

$(1.01539)^{12} - 1 = 20.1\%$ (1)

Exact answer = 19.41%

Question #2 (5 marks)

Given the four mutually exclusive 10 year investment opportunities, determine the best opportunity using the IRR method. Assume MARR = 12%.

	FC	Annual Saving	Salvage Value	IRR
A	80,000	13,000	10,000	11.0%
B	120,000	23,000	34,000	15.8%
C	145,000	24,000	25,000	11.8%
D	145,000	28,000	29,000	15.5%

A - no good IRR < MARR (1)

B - OK

C - out, IRR < MARR (1)

D - B

FC	AS	Salvage
25000	5000	-5000

equal to at year 10 have zero CF

$\therefore 25k = 5k(P/A, i, 9)$ (2)

try $i = 0.12$

RHS = 26 641

RHS > LHS $\therefore i_{D-B} > 12\%$, i.e. > MARR

$\therefore$ pick D (1)

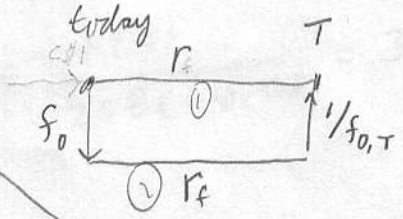
Question #3 (16 marks)

You work for a Canadian based company (operating in C$) and the company has just made an €800,000 sale in Europe. The equipment will be delivered 1 year from now. You will be paid 20% up front and the remaining 80% on delivery. The materials required to manufacture this equipment will cost US$300,000 from the US and C$200,000 from Canada. You estimate the labour costs to be $300,000. The US materials will need to be paid for 6 months from now. The Canadian material costs will be paid equally at the end of months 1 to 6. The labour costs will be paid equally at the end of each of the 12 months to the delivery date. The annual risk free rate (all rates based on continuous compounding) in Canada is 4%, while in the US it is 3% and in Europe it is 5%. The current foreign exchange rates are 0.85 US$/C$ and 0.62 €/C$.

A. Determine the forward exchange rates for US$/C$ six months from now and for €/C$ one year from now (4 marks).
B. Assuming you will hedge the project by entering into the respective forward contracts, draw the cash flow diagram for this project in C$ (5 marks).
C. Calculate the present worth of the project, assuming you will hedge your cash flows by entering into foreign exchange forward contracts and the company annual MARR is 12% based on monthly compounding (5 marks).
D. What is the gross margin and gross margin % for this project (again, assume you hedged your foreign exchange exposure) (2 marks)?

A. To avoid arbitrage (as per problem set) an investment at the risk-free rate in Canada today has to give same payoff as converting C$ today to a foreign currency, investing at the foreign risk-free rate ~~at~~ and today, entering into a forward contract to exchange the risk-free investment back to C$.

- let f_0 denote FX rate today in foreign currency/C$
- let $f_{0,T}$ " " forward rate today for time T in foreign curr/C$



① invest $1 (CAD)
C$1 investment;
value at time $T = e^{rT}$
r = r-f rates in Canada

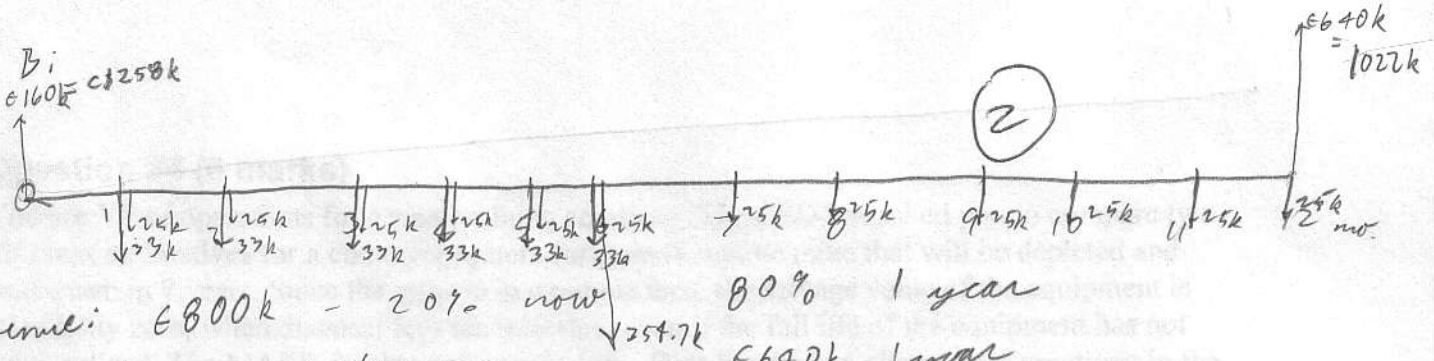
② value of C$1 invested in foreign:
$\frac{f_0}{f_{0,T}} e^{r_f T}$

$\therefore e^{rT} = \frac{f_0}{f_{0,T}} e^{r_f T}$

$\therefore f_{0,T} = f_0 e^{(r_f - r)T}$ (2)

for US:
$f_0 = 0.85, \quad T = 0.5$
$\therefore f_{0,T}^{US} = 0.85\, e^{(0.03-0.04)0.5}$
$= 0.8458$ (1)

for EU
$f_0 = 0.62, \quad T = 1$
$f_{0,T}^{EU} = 0.62\, e^{(0.05-0.04)\times 1}$
$= 0.6262$ (1)



Revenue: €800k - 20% now

354.7k

80% 1 year

€640k 1 year

-i €160k now

$\therefore$ $\frac{€160k}{0.6262€/C\$} = C\$258,065$ (1)

$\frac{€640k}{0.6262€/C\$} = C\$1022k$ (1)

US costs: $\frac{US\$300k}{0.8458 US\$/C\$} = C\$354.7k$ (1)

CAD costs: 200k over 1st 6 mo : 200k/6 = 33k

300k over 12 mo : 300k/12 = 25k

C. MARR = 1% per month

$PW = 258k - 33k(P/A, 1\%, 6) - 25k(P/A, 1\%, 12) - 354.7k(P/F, 1\%, 6)$ (3)

$+ 1022(P/F, 1\%, 12)$

$= C\$356,313$ (2)

D. $GM = REV - COGS$ (BUT NO DISCOUNTING!)

$= 258k + 1022k - (354.7k + 300k + 200k)$

$= C\$425,341$ (1)

$GM\% = \frac{425k}{258k + 1022k} = 33.2\%$ (1)

Question #4 (6 marks)

You are VP of operations for a small mining company. The CEO has asked you to compare two different alternatives for a conveyor system for a small remote mine that will be depleted and shut down in 7 years. Since the mine is in a remote area, the salvage value of the equipment is essentially zero, when disposal fees are included, even if the full life of the equipment has not been utilized. The MARR for the company is 10%. Data for the two alternatives are given in the table below. Provide your recommendation to the CEO and show the resultant cash flow diagram for your recommendation.

	Option A: Fast Conveyor	Option B: Quality Conveyor
Expected Life	3	4
Price	400,000	500,000
Annaul Op. Cost	70,000	50,000

Potential Options: - we can do A 3 times, B twice, or A then B or B then A

A	B	A	B
A	B	B	A
A			
①	②	③	④

- unequal lives, first thing need to do is calculate AC

Option A: $AC_A = 400k(A/P, 0.1, 3) + 70k = 231k$ ①

Option B: $AC_B = 500k(A/P, 0.1, 4) + 50k = 208k$ ①

- since $AC_B < AC_A$ we can immediately eliminate option ① - ie. go with A 3 times (ie years 0, 3, 6)
- now we are left w/ options ②, ③ or ④
- since $AC_B < AC_A$ - for sure option ④ is better than ③ - so we are left w/ option ② or option ④ - so let's check PC (Present cost)

② for getting to the 2 final options:

0-4 | B | or | B |
4-7 | B | | A |

$$PC_④ = AC_B \times (P/A, 0.1, 4) + AC_A \times (P/A, 0.1, 3) \times (P/F, 0.1, 4)$$

$$= 1051k$$

FAST CONVEYOR

$$PC_② = 500k + 50k \times (P/A, 0.1, 7) + 500k(P/F, 0.1, 4)$$

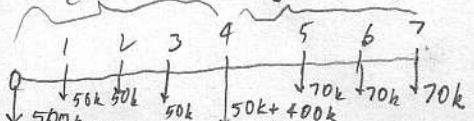
$$= 1085k$$

$\therefore PC_④ < PC_②$ ①

we go with B then A.

QUALITY CONVEYOR

CF



①

Question #5 (5 marks)

A bond with a maturity date of 10 years and 1 month from now pays coupons on a quarterly basis. The yield is 6.2% (based on quarterly compounding) and the price of the bond is $100.84 (based on $100 face value). What is the coupon rate (express the coupon rate based on an annual rate, as per convention)?

- 10 years + 1 month means 41 coupon payments (1)

$i_{1/4} = 0.062/4 = 1.55\%$

$100.84 \times (P/F, 1.55\%, 2/3) = 100 \times \frac{CR}{4} \times (P/A, 1.55\%, 41) + 100(P/F, 1.55\%, 41)$ (2)

$\therefore CR = 6.175\%$ (2)

or

$100.84 = \left(100 \times \frac{CR}{4}(P/A, 1.55\%, 41) + 100(P/F, 1.55\%, 41)\right) \times (F/P, 1.55\%, 2/3)$

$\therefore CR = 6.175\%$

Question #6 (8 marks)

A small municipality (population 20,000) is looking to issue one thousand $1,000 bonds to raise $1 million to finance a capital expenditure whose life is expected to be 5 years. Coupon payments will be paid semi-annually. A larger municipality (population 40,000) has strip bonds (zero coupon bonds) with a maturity of 4 years and 3 months from now priced at $78.06. Because of the market perceived risk associated with the default potential of small municipalities, assume the continuously compounding yield spread on the small municipality to the larger one is 0.2% (i.e. yield of small municipality = yield of larger municipality + 0.2%). What is the minimum coupon rate required to ensure that the $1 million will be raised assuming a 2% cost associated with the bond issuance?

larger muni: $78.06 = 100\, e^{-r(4+\frac{3}{12})}$

$\therefore r = 0.0583$ (2)

$\therefore$ for smaller muni:

$r = 0.0583 + 0.02$

$= 0.0603$ (1)

- for semi-annual:

$r_{semi} = e^{0.0603/2} - 1$

$= 0.0306$ (1)

now for 2% financing cost, must ~~raise~~ get $\frac{100}{1-0.02}$ per bond or the price

(2) $\frac{100}{1-0.02} = \frac{CR}{2} \times 100\,(P/A, 0.0306, 5\times 2) + 100\,(P/F, 0.0306, 5\times 2)$

$\therefore CR = 0.065998$

or

0.0660 (2)