

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, APRIL 2001

Third year - Program: Chemical Engineering

CHE349H1S - ENGINEERING ECONOMIC ANALYSIS

Exam Type: X

Examiner - M. Asmild

There are 9 different parts of this exam and the total of 80 marks is distributed as follows:

1) 6 marks, 2) 5 marks, 3) 8 marks, 4) 10 marks, 5) 9 marks, 6) 8 marks, 7) 10 marks,
8) 12 marks, 9) 12 marks

1. Throughout the course in Engineering Economics we have talked a lot about recession in the US and Canada.
 - a) Mention some of the typical signs or indicators of recession.
 - b) What industry is usually particularly sensitive to recession and thus slows down at the first signs of recession (or maybe even the talk of recession)?
 - c) What measures can the Canadian Government use to stimulate the Canadian economy and how are these measures expected to work?
2. Economic recession also affects inflation. Inflation is typically measured by means of a price index, such as for instance the Consumer Price Index (CPI).
 - a) Describe briefly how the CPI is calculated. Can you think of any problems with measuring inflation this way?
 - b) Some people actually benefit a lot from inflation - who?
3. In the business section of a newspaper you can find prices on bonds, such as those shown on the next page (from the Globe and Mail, March 1, 2001).

You suddenly discover that it is possible to install solar panels instead. The solar panels will cost \$8000 to buy and \$1000 to install. They will save you \$1500 in energy costs each year, and are assumed to have no maintenance costs for the first 5 years and a salvage value at the end of year 5 of \$2500.

- b) Use an incremental analysis to determine whether you should invest in the solar panels instead of the natural gas furnace, with a MARR of 10%. Use a study horizon of 5 years for both alternatives.

6. A company is evaluating whether it should buy a new heat exchanger, which has a first cost of \$80,000, and the following estimates for the yearly savings and useful lives. Assume that the heat exchanger has no salvage value at the end of its useful life, and use an interest rate $i=9\%$.

Savings per year	Probability	Useful life (years)	Probability
18,000	0.15	7	1/6
20,000	0.75	5	2/3
22,000	0.10	4	1/6

- a) What is the present worth of investing in the heat exchanger?

Assume now that the useful life for the heat exchanger is 5 years, but that the annual savings are still uncertain.

- b) What are the break-even annual savings?
c) What are the break-even annual savings if it costs \$5000 to install the heat exchanger.

7. An old wooden bridge over a bay is in danger of collapse. The highway department is currently considering two alternatives to alleviate the situation and provide for expected increases in future traffic. One plan is a conventional steel bridge, and the other is a tunnel under the bay. The department is familiar with bridge construction and maintenance, but has no experience with maintenance costs for tunnels. The following data has been developed for the bridge:

First cost	\$17,000,000
Painting every 6 years	\$1,000,000
Deck resurfacing every 10 years	\$3,000,000
Structural overhaul at the end of 15 years	\$4,000,000
Annual maintenance	\$300,000

The tunnel is expected to cost \$23,000,000 and will require repaving every 10 years at a cost of \$2,000,000. Both designs are expected to last 30 years with negligible salvage value.

- a) Determine the maximum value of the equivalent annual costs of other maintenance for the tunnel (except repaving) so that the tunnel would be chosen instead of the bridge. Let $i=7\%$.

Assume instead that we have some information about the yearly tunnel maintenance costs, which is that it is expected to be low=\$80,000 with a probability of 20%, medium=\$100,000 with a probability of 50% or high = \$150,000 with a probability of 30%.

- b) Which solution will now be preferred?

Because the politicians making this decision worry more about reelection next year than the future costs resulting from their decision, they decide to go for the solution with the lowest first costs. Furthermore they realise, that they can save \$2,000,000 on the first cost by omitting a certain safety feature. The estimated consequence of not having this is one fatal accident every 10 years.

- c) How much can you pay out in compensation to the relatives at the end of year 10, 20 and 30 respectively (equal amounts, so this resembles an annuity), and still benefit from omitting the safety feature? Use an annual interest rate $i=7.2\%$ (and transform this into the 10-year interest rate). Ignore any inflation considerations.

8. On the last page (page 6) you can find financial statements for two companies, ABC and DEF.

- a) Calculate 2 ratios for each of the two companies, which describe how good they are at generating profit.
- b) Calculate a ratio that indicates what yield you get from shares in the companies.

There is also a certain risk involved with such an investment. Other companies in this industry have gone bankrupt, especially because the sector they sell their products to is in crisis, so they may run into problems collecting their debts.

- c) Calculate 3 different ratios, which illustrates how sensitive the two companies are to this problem.
- d) After evaluating all these ratios, which of the companies would you prefer to invest in? Briefly explain why.

For their future operations both of the companies need to invest \$1,000,000 in a new piece of equipment, which will be depreciated over 5 years, and has a salvage value at the end of year 5 of \$100,000. Assume now that one of the companies is operating in the US and the other in Canada. The Canadian company is limited to using straight line depreciation for tax purposes, whereas the US company can use double-declining balance or OSYD depreciation as well, and will choose the depreciation method that will maximise the present worth of its tax deductions. Both companies are assumed to make enough profit every year to be able to get the full advantage of the tax deduction resulting from the depreciation. The US company pays 40% income tax and the Canadian company pays 50% income tax.

e) Which of the companies has the largest worth of its tax deduction? Use an interest rate $i=8\%$.

9. At years end ABC had assets and liabilities as shown in their financial statement. During the following fiscal year the following events occur:
(Note that all values are still in thousands of dollars).

- They sell \$1000 worth of goods from their inventory for \$3000.
 - They receive \$2000 cash from a debtor.
 - They pay back their short-term loan with cash.
 - They sell all their marketable securities (at their book value).
 - They pay the salaries they owe their employees.
 - They pay half of their "accounts payable" with cash.
 - They buy \$2500 worth of goods on credit.
 - The debtor who owes them the outstanding amount on their "accounts receivable" goes bankrupt, so they will never get those money. Register this loss under "other expenses".
- a) Prepare T-accounts for ABC. Suggested accounts: Cash, marketable securities, accounts receivable, inventory, other assets (starting value \$60,000), accounts payable, short-term loan, salaries payable, other liabilities (starting value \$43,000), shareholders equity, sales, COGS, other expenses.
- b) Prepare an income statement for ABC. Assume that the company had the following expenses: "COGS" and "other expenses" as found in the T-accounts and "operating expenses"=\$500. Assume that the operating expenses and a 50% income tax are paid cash, and adjust the cash T-account accordingly.
- c) Prepare the balance sheet for ABC, keeping long-term assets and long-term liabilities constant.

Balance Sheet
December, 31, 2000
(all values in thousands of dollars)

	ABC	DEF
Assets		
<u>Current assets</u>		
Cash	1000	1000
Marketable securities	2000	1000
Accounts receivable	3000	6000
Inventory	<u>4000</u>	<u>2000</u>
Total current assets	10000	10000
<u>Long term assets</u>		
Land	10000	30000
Buildings	20000	30000
Equipment	<u>30000</u>	<u>20000</u>
Total long term assets	60000	80000
Less accumulated depreciation	<u>10000</u>	<u>1000</u>
Total net long term assets	50000	79000
Intangibles	<u>10000</u>	<u>1000</u>
Total assets	70000	90000
Liabilities		
<u>Current liabilities</u>		
Accounts payable	5000	1000
Short term loan	2000	7000
Salaries payable	<u>1000</u>	<u>3000</u>
Total current liabilities	8000	11000
<u>Long term liabilities</u>		
Bonds	<u>43000</u>	<u>58000</u>
Total liabilities	51000	69000
Shareholders equity		
(No. common stock authorized	150000	100000)
(No. common stock outstanding, \$50 par value	120000	100000)
Value of outstanding stock	6000	5000
Retained earnings	<u>13000</u>	<u>16000</u>
Total shareholders equity	19000	21000
Income statement		
Sales revenue	20000	40000
Costs of goods sold	<u>10000</u>	<u>20000</u>
Gross margin	10000	20000
Operating expenses	<u>5000</u>	<u>8000</u>
Income before taxes	5000	12000
Taxes 50%	<u>2500</u>	<u>6000</u>
Net profit	2500	6000
Dividends	<u>2000</u>	<u>2000</u>
Ret. earnings	500	4000
(Market price of common stock (in actual dollars)	50	55)