Engineering Economics and Problem Solving, 4N4

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Note:

- **Only use dollar figures in the midterm; never include cents**. Also round to the closest $1000 dollars when dealing with large currency values.
- You may bring in any printed materials to the midterm; any textbooks, any papers, *etc*.
- Some tables of cost correlations are included in the exam; please use these where appropriate.
- You may use any calculator during the midterm.
- You may answer the questions in any order on all pages of the answer booklet.
- *Time saving tip*: please use bullet points to answer, where appropriate, and **never repeat the question** back in your answer.
- Time management on this exam is important. **Please scan the entire exam before you start, so you know where you will require more time**.
- There are 7 questions, graded out of 100 marks (+ 5 bonus marks), 10% of course grade.
- Total time: 2 hours. There are 4 pages in the exam, please ensure your copy is complete.

Question 1 [20 = 2 + 2 + 1 + 1 + 2 + 1 + 1 + 2 + 2 + 2 + 1 + 3]

Provide single word, or short sentence answers to the following (no explanation, no equations).

1. FOB means .... (do not simply give the full acronym, please describe what it means)
2. Payback time, as taught in 4N4, can be described as ....
3. If a potential investment has a DCFRR of 28%, and the company's MARR is 30%, would you recommend to your manager to proceed with this project?
4. The corporate tax rate in Canada for a company with revenues exceeding $5 million (i.e. a large company) is approximately .... [give a range]%
5. The abbreviation "CCA" is the CRA abbreviation for .... or otherwise known as ....
6. The CRA allows using the straight-line method for most types of capital expenses. True or false?
7. In a sentence, describe what should be done in an NPV analysis with installation costs ($56,400) of a second-hand compressor that your company bought on eBay for $295,000.
8. The effective interest rate for a nominal annual interest rate of 15% when compounded weekly (52 weeks per year) is ....
9. Depreciation in the first year for equipment costing $34,200, in CRA class 43 is ....
10. The book value for this same piece of equipment at the **end** of the 3rd year of its full-time use is ....
11. If we are comparing two independent alternatives, we must **(a)** ensure the NPV is positive, **(b)** ensure the DCFRR exceeds the MARR, or **(c)** both options (a) and (b) must be met for each alternative.
12. Name 6 type of expenses (costs) that are included in the bare module factor when estimating capital costs.

Question 2 [3]

A new aluminum plant is expected to cost between $900 to $1400 million to build. The current aluminum price is $2080 per tonne. What would be your estimate of the expected capacity (tonnes per year) for this plant. Justify your answer.

Question 3 [20]

Your company has a maximum of $55,000 to invest in 2013. The MARR for your company is 13% before tax (i.e. without considering taxes).

Three potential projects are available for economic evaluation; they are described below. They are all technically feasible, no project is required, any combination can be implemented (they are technically independent), and they have the same risk. All projects have the same life of six years. You are to recommend which project(s) should be executed, if any. You must show all calculations and provide a clear recommendation with brief explanation.

Project A has been evaluated by a colleague in your company, with the following results.

- Investment = $20,000 in 2013
- NPV in 2013 = $734 (with MARR = 13%)
- DCFRR = 15%

Project B has these details:

- Investment = $20,000 in 2013
- Net income reported below = revenues − operating expenses, and does not include the original investment:

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Net income	6500	6000	5000	4500	4000	3500

Project C has these details:

- Investment = $30,000 in 2013
- Net income reported below = revenues − operating expenses, and does not include the original investment:

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Net income	5000	8000	8000	8000	8000	10000

Question 4 [30 = 10 + 20]

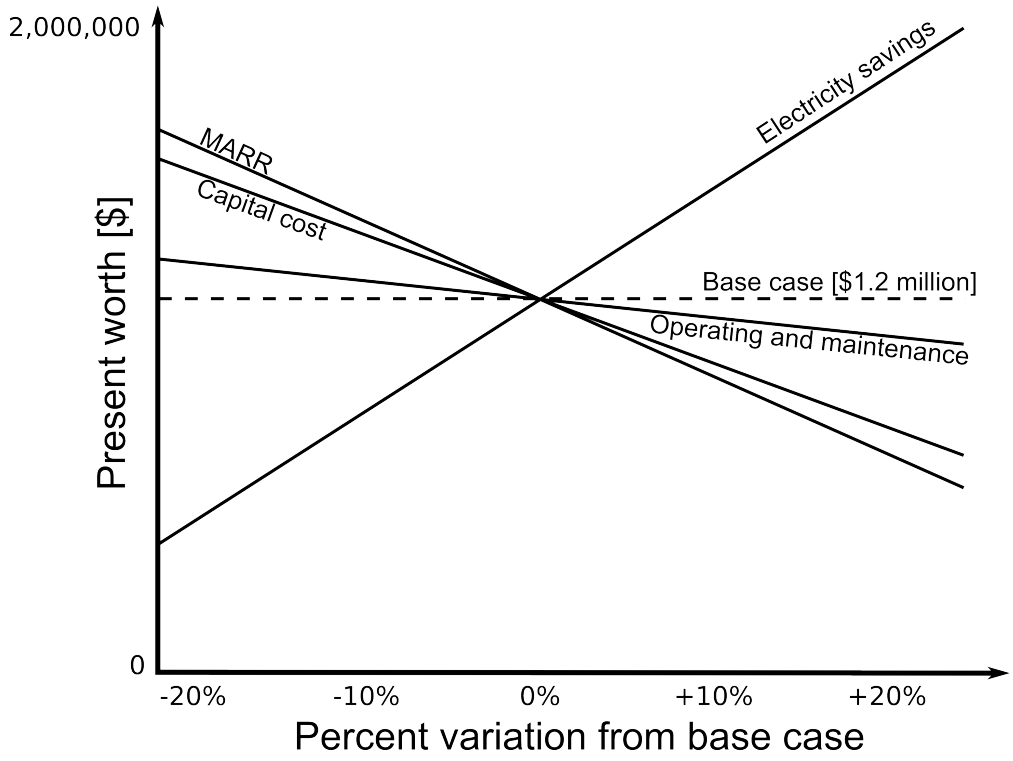
It is August 2011. The demand for your company's solvent has steadily been growing. Many successful attempts have been made to increase overall throughput to meet the demand. But the key constraint your team has identified is to install an additional reboiler on the final distillation column that purifies the solvent.

Computer modelling shows that a heat transfer area of 600 m^2 in the reboiler is required to generate a distillate purity and flow rate to satisfy market demand. Note the entire plant is constructed from 316 stainless steel to resist this solvent's corrosive effects. This is a standard, off-the-shelf unit available from most vendors, so it will be installed and ready for use by January 2012.

1. Calculate the cost of the reboiler, delivered, installed and ready to operate.
2. Assume the reboiler costs $1,000,000, and assume the increased purity and flow of solvent with the new unit will lead to increased sales of $350,000 per year. The reboiler will become part of your company's annual maintenance plan, so costing an additional $5000/year in maintenance. The cost of steam to operate the reboiler is estimated at $14,000 per year. Considering taxes (corporate rate of 35%), depreciation (30%, declining balance) and time value of money (MARR of 15%), find the point in time where this investment would break even [give the approximate month and year] taking tax, depreciation, and time value of money into account. Do not consider inflation of costs and income in this question.

Question 5 [11 = 9 + 2]

A company is looking at replacing its current steam generation plant with a single cogeneration plant, producing both steam and electric power. The electric power produced will reduce their dependance on Hydro One (their current electric supplier). The total capital cost has been estimated from the bare module method and from some vendor quotations. The company's MARR is 18%. An NPV analysis over a 20 year time period was performed, followed by a typical sensitivity analysis, shown below.



1. What 3 key pieces of information would you include in the cover letter/email to your manager regarding this sensitivity analysis?
2. And what main caution regarding the sensitivity analysis would you be sure to highlight in the cover letter/email?

Question 6 [15]

Trick-or-treat from group B8 (slightly modified by me)

A candy manufacturing company, H, wants to increase its production for Halloween by adding equipment required for production. Due to the increased production the company will get a significant boost in profit. The company has an option of either buying or leasing the equipment. To buy it, the company must pay an upfront cash amount of $40,000 and $5,000 for installation. If not, the company can lease it for $12,000 for 5 years from company L. Company H will start making profit as soon as the new equipment is in place. Company H will have an annual maintenance cost of $3,000. Leasing company L takes care of installation and maintenance for the lease option.

Prepare your calculations for determining whether leasing or buying the equipment would be better for company H.

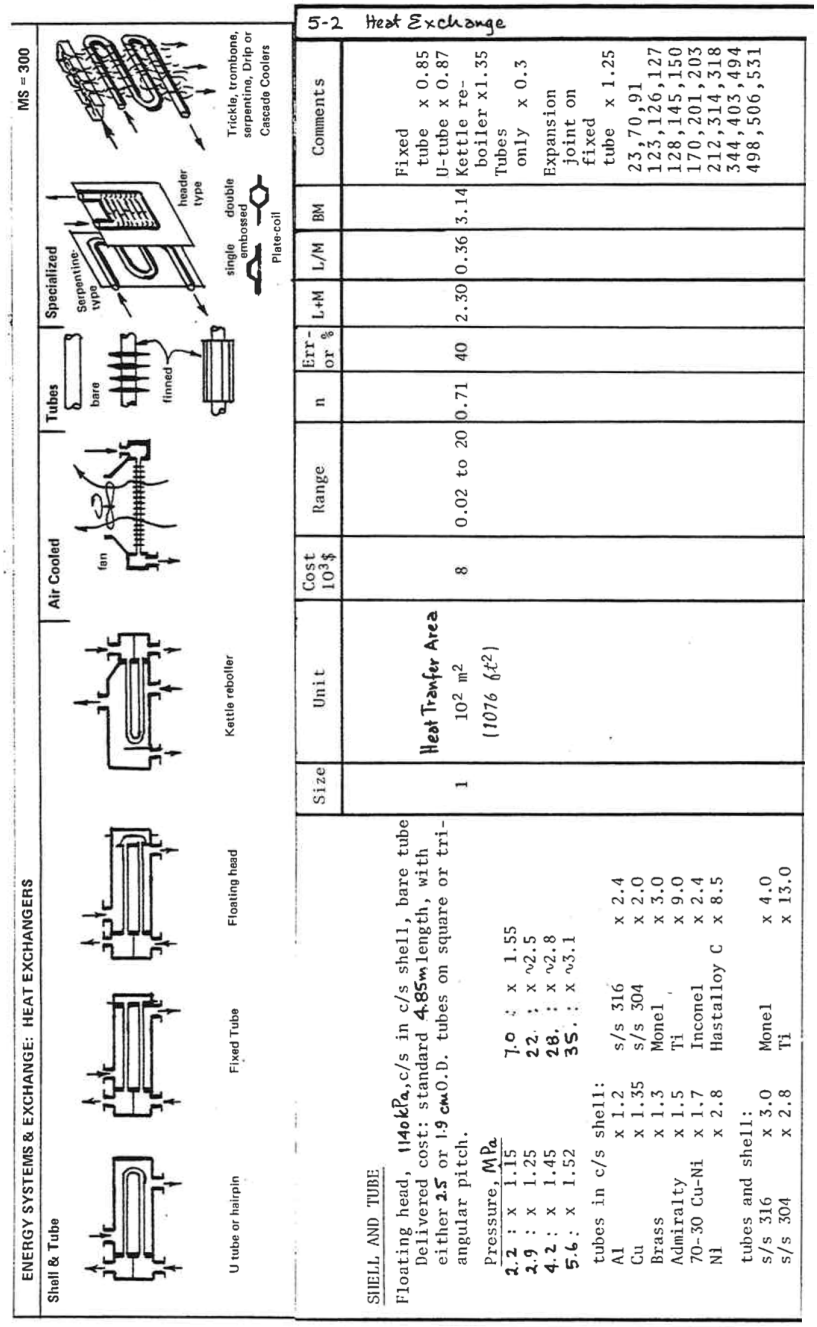
Clearly write your assumptions, and only show calculations for the first two periods (years) for both the lease and buy scenario. Your calculations must be detailed enough to follow clearly.

Use the values after 2 years to demonstrate how you would have determined if leasing or buying the equipment would be better for company H. (Obviously you would normally do this in a spreadsheet over a longer period.)

Question 7 [6]

A large chemical plant's "internal" price of steam is set by many factors, some of which are outside their control (e.g. price of natural gas and water). However, there are factors that they can control and adjust day by day. Clearly describe at least 3 such factors that **are within their control** and how it might affect their internal steam costs.

Cost correlation tables



ENERGY SYSTEMS & EXCHANGE: HEAT EXCHANGERS — MS = 300

Shell & Tube: U tube or hairpin; Fixed Tube; Floating head; Kettle reboiler

Air Cooled: fan

Tubes: bare; finned

Specialized: Serpentine-type; header type; single; double; embossed; Plate-coil; Trickle, trombone, serpentine, Drip or Cascade Coolers

5-2 Heat Exchange

SHELL AND TUBE

Floating head, 1146 kPa, c/s in c/s shell, bare tube
Delivered cost: standard 4.85 m length, with either 2.5 or 1.9 cm O.D. tubes on square or triangular pitch.

Pressure, MPa	
2.2 : x 1.15	7.0 : x 1.55
2.9 : x 1.25	22. : x ∿2.5
4.2 : x 1.45	28. : x ∿2.8
5.6 : x 1.52	35. : x ∿3.1

tubes in c/s shell:

Al	x 1.2	s/s 316	x 2.4
Cu	x 1.35	s/s 304	x 2.0
Brass	x 1.3	Monel	x 3.0
Admiralty	x 1.5	Ti	x 9.0
70-30 Cu-Ni	x 1.7	Inconel	x 2.4
Ni	x 2.8	Hastalloy C	x 8.5

tubes and shell:

s/s 316	x 3.0	Monel	x 4.0
s/s 304	x 2.8	Ti	x 13.0

Size	Unit	Cost 10^3 $	Range	n	Error %	L+M	L/M	BM	Comments
1	Heat Transfer Area 10^2 m^2 (1076 ft^2)	8	0.02 to 20	0.71	40	2.30	0.36	3.14	Fixed tube x 0.85; U-tube x 0.87; Kettle reboiler x1.35; Tubes only x 0.3; Expansion joint on fixed tube x 1.25
									23,70,91
									123,126,127
									128,145,150
									170,201,203
									212,314,318
									344,403,494
									498,506,531

The end.