

# Engineering Economics and Problem Solving, 4N4

## Written midterm, 16 October 2013

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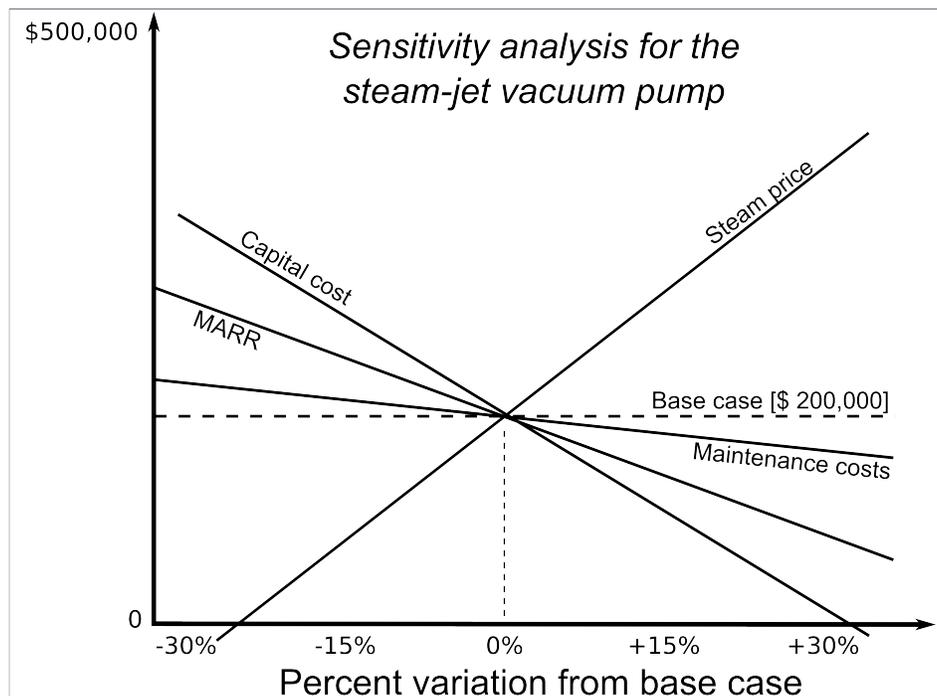
### Note:

- **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 5 questions, graded out of 88 marks (+ 4 bonus marks), 10% of course grade.
- Total time: 2 hours (nominally, but you will have “infinite” time to complete it). There are 4 pages in the exam, please ensure your copy is complete.

### Question 1 [11]

Your company is considering an option to replace an aging vacuum pump. There are two options available: either use a newer technology steam-jet vacuum pump, or an electrically driven vacuum pump.

For the final meeting to make a decision, a colleague in the company has created the following slide; but he's off sick today. Your manager asks you interpret his work.



What do you tell your colleagues in the meeting?

**Question 2 [23 = 3 + 3 + 4 + 3 + 1 + 3 + 1 + 3 + 2 + (bonus 2+2)]**

Provide single word, or short sentence answers to the following (no explanations, no equations, unless you feel you really need it).

1. When it comes to expenses that can or cannot be depreciated, write which of the following expenses can be included in the book value for a new pump? [3]
  - shipping fees for the pump's motor
  - cost of electricity to operate the motor
  - annual preventative maintenance to ensure it can reach its 10-year life-expectancy
  - cost of labelling, insulation and painting of pipes to the pump
2. Your colleague from the marketing and sales department asks you to explain a phrase she keeps seeing in engineering reports: "this project has an NPV of \$24,000 over its 3 year life span". Write down your response. [3]
3. A second hand centrifuge for your laboratory had a cost of \$30,000. According to CRA, it can be depreciated in class 43. It has a remaining life span of 5 years and a expected salvage value of \$2,600. You bought it in September 2012 and your corporate tax year ends on 30 November. [4]

What is the amount of depreciation that can be written off

- (a) at the end of November 2012
  - (b) at the end of November 2014
4. If all you know about two independent projects is they have a DCFRR of 24% and 42% respectively, and the MARR for either project is 20% [3]
    - (a) What would your recommendation be for spending money on each project?
    - (b) Explain why.
  5. The term "CCA" is the CRA abbreviation that stands for .... [1]
  6. Using the CEPCI composite index, how much would a small compressor that cost \$88,000 in 2004 cost us in 2012? [3]
  7. CEPCI stands for .... [1]
  8. Periodically the government changes the depreciation rate for certain equipment types, but allows you to choose the lower or higher rate (this is called "an election" in the official documents). Explain clearly either
    - **why** a higher depreciation rate is *more* advantageous for a company, **or**
    - **why** a higher depreciation rate is *less* advantageous for a company.Pick the option you feel is most correct and clearly explain in your answer why. [3]
  9. Explain why an MARR for the same multi-national company (e.g. Shell) in the same sector (e.g. petrochemicals) can be different from one country to country. [2]
  10. *Bonus* [+2]: What is an approximate cost of electricity for a company in Canada (you must be at least within 40% of average pricing)?  
*Even greater bonus* [+2]: What is the cost of electricity in Ontario? (It's been making [news over the Thanksgiving weekend](#)).

### Question 3 [26]

A company builds a full-scale plant today for the cost of \$1,500 with capacity of 1200 tons/year. The cost of operating the plant is \$0.4 per ton of product, the sales price is \$1 per ton, taxes are at 25%, and depreciation is class 43 from CRA. Assume we sell everything we produce. Assume the plant can be built and operated in almost no time (it uses off-the-shelf components that are easily assembled). The company's MARR is 10%, indicating we are in a relatively risk-free, low-tech sector.

The following market **demand** exists for our product:

Year	2013	2014	2015	2016	2017
Market <b>demand</b> (tons per year)	600	800	1000	1200	1200

*Your task:* show only the calculations to calculate the NPV of all cash flows from 2013 to 2017. Use a neat table, with detailed notes for the first two periods. Subsequent periods can just report the values. There must be **no calculations** inside your table, only final amounts. Use rounded values, and note that all numbers here refer to \$000's of dollars.

### Question 4 [15]

Ten to 15 years from now you could easily be the engineering manager for your division. The finance department has allocated a budget of \$43 million to your group. You have to meet with the Chief Financial Officer (CFO) tomorrow morning to explain your budget. She has a finance degree so you have to communicate effectively with her to get the budget approved. Methodically and clearly describe how you will convince her to approve the budget - she will want to see numbers and data as proof. The finance office has set a MARR of 20%.

These 4 independent projects are under consideration and have mostly similar life times. Do not take tax and depreciation into consideration, because the error estimates on the capital costs are still too large - this is just a preliminary screening. This is all the information you have from your engineering team to work with.

#### Project A has

- Investment = \$25 million in 2013 and payback time = 40 months
- NPV for 2013 to 2016 cash flows = \$17.4 million using a TVM of 20%
- DCFRR = 26%

#### Project B has these details:

- Investment = \$38 million in 2013 and payback time = 47 months
- NPV for 2013 to 2017 cash flows = \$15.4 million using a TVM of 20%
- DCFRR = 52%

#### Project C has these details:

- Investment = \$6 million in 2013 and payback time = 22 days
- NPV for 2013 to 2015 cash flows = \$145 million using a TVM of 20%
- DCFRR = 1482%

#### Project D has these details:

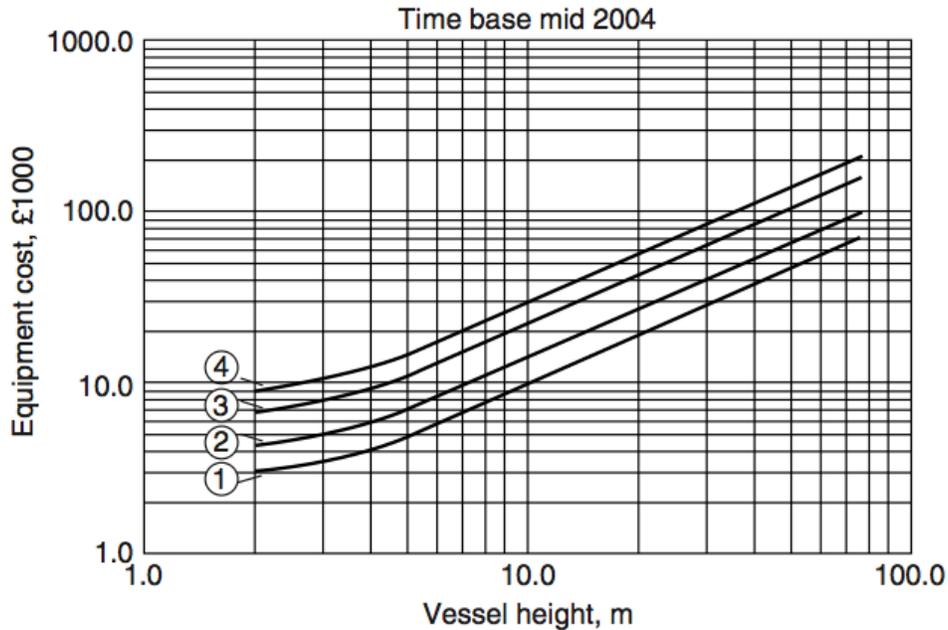
- Investment = \$20 million in 2013
- Net income reported below = revenues – operating expenses, and does not include the original investment:

Year	2013	2014	2015	2016
Net income (\$ millions)	6.5	6.0	5.0	4.5

**Question 5 [13]**

You are wanting to estimate the cost of a vertical pressure vessel, essentially a flash drum. Your current design calls for a unit that is 9.0 m tall and 2 m in diameter. It must be made from stainless steel cladding, operate at 250°C and 35 bar (typically), but for safety reasons must withstand temporary deviations up to 50 bar.

You don't have the Dr. Don Woods correlations, but there is a copy of a British Chem Eng textbook (Coulson and Richardson volume 6) with this plot available that gives the bare module cost in pounds.



Diameter, m		Material factors	Pressure factors
①—0.5	③—2.0	C.S. × 1.0	1–5 bar × 1.0
②—1.0	④—3.0	S.S. × 2.0	5–10 × 1.1
		Monel × 3.4	10–20 × 1.2
		S.S. clad × 1.5	20–30 × 1.4
		Monel × 2.1	30–40 × 1.6
		clad	40–50 × 1.8
			50–60 × 2.2

Temperature up to 300°C

$$\text{Purchased cost} = (\text{bare cost from figure}) \times \text{Material factor} \times \text{Pressure factor}$$

The one advantage you immediately notice for this correlation is that the error levels are  $\pm 25\%$ . The exchange rates were:

- 1.00 British pounds = 1.80 US dollar in 2004 (previous version of the test had this reversed)
- 1.00 British pounds = 1.57 US dollar in 2012 (previous version of the test had this reversed)

This correlation already has the bare module costs included, and should be used in the straightforward manner described.

Give a cost estimate, with error, for this pressure vessel, in dollars, in 2012.

**The end.**