

Engineering Systems Analysis for Design**Mid-Semester Quiz****October 23, 2007**

This is a closed book exercise. Computers and other wireless enabled devices for communication with web and outside are not allowed.

You may use old-fashioned, non-communicating calculators that are not miniature computers with extensive memory (if you have them! And if so, show me first...)

Grade Table

There are 90 points possible for the regular test. Points associated with each question correspond to the estimated time it might take to answer them. .

Item	Score	
	Max	Yours
Your Name (provided we can read it)	1	
Concepts	26	
What's the best design?	21	
Static valuation of projects	11	
Effect of Uncertainty on Design	13	
Decision Analysis	18	
Total	90	

I have completed this test fairly, without copying from others, a book, or the web.

Please sign your name legibly _____ **(1 point)**

Feedback voluntary question (no credit):

Suggest a CD for classroom enjoyment in second half of semester:

Concepts (26 points)

Note: Full marks only for conceptually precise responses

Write a short definition or description explaining the following:

Technical Efficiency **(2 points)**

Production Function **(2 points)**

Economic Efficiency – define and contrast with Technical Efficiency **(2 points)**

Criterion for Attaining Technical Efficiency **(2 points)**

Isoquant **(2 points)**

Increasing Returns to Scale **(2 points)**

Economies of Scale – define and contrast with IRTS **(3 points)**

Expansion Path **(2 points)**

Output Cost Function -- define and compare with input cost function **(3 points)**

Discount Rate -- define and compare with interest rate **(3 points)**

WACC – define concept and discuss advantages and disadvantages for use as discount rate **(3 points)**

What's the best design? (21 points)

You are given a production function: $Z = R^{0.3} S^{0.6}$

And the cost of the resources as: $C = 1.5 R^{0.8} + 2 S^{1.2}$

Note: In calculating answers, you may leave exponents in fractional form rather than estimating numbers in decimal form. For example, $0.4^{2/3}$ would be acceptable.

- a) What can you say immediately, by inspection, about the returns to scale? The economies of scale? Explain answer **(3 points)**
- b) What is the economically efficient relationship between the resources R and S? **(6 points)**
- c) What is the associated cost function? **(8 points)**
- d) What can you now say about the economies of scale? Explain why this is so **(4 points)**

Static Valuation of Projects (11 points)

Consider the project with the following revenues and costs:

	Year				
	0	1	2	3	4
Revenues		60	100	220	380
Costs	190	12	28	47	70
Net Cash Flow					
$(1+r)^N$					
Present value					

Assume a discount rate of $r = 20\%$. Use no more than 3 significant figures

a) Define Net Present Value and calculate it for this case **(5 Points)**

b) How would you calculate the benefit-cost ratio? What are the major advantages and disadvantages of the Benefit/Cost ratio as a criterion of evaluation? **(3 points)**

c) Define and Calculate the Pay Back Period. What are the major advantages and disadvantages of this criterion of evaluation? **(3 points)**

Effect of Uncertainty on Design (13 points)

a) Under what circumstances is the value of a project, when calculated on the basis of the most likely forecasts, the same as its value when calculated for the range of possible scenarios that lead to those most likely forecasts? **(3 points)**

b) So, how likely is it that the valuation based on the most likely forecasts are correct? **(2 points)**

c) What are the advantages of a staged approach that allows the designer to achieve a capacity through several increments, instead of one? **(2 points)**

d) What are the disadvantages of the staged approach? **(2 points)**

e) Illustrate how a staged approach could affect the Value at Risk and Gain of the value of a project. **(4 points)**

Decision Analysis (18 points)

As the systems engineer for the Copper Cable Company (CUCACO) you need to establish their production plan for a new 3C product over the next 2 years. A key decision concerns the purchase of Copper. Should CUCACO buy copper on a:

- Fixed contract for 2 years, or
- Flexible contract that will change at the end of the first year?

The fixed contract is stable. However, the flexible contract might save CUCACO money if the price goes down or if CUCACO decides to close operations. The fixed contract will cost \$5M a year for 2 years. The flexible contract costs \$6M for the first year, but is equally likely to rise to \$10M in the second year, or to fall to \$1M.

Note the following economic context. CUCACO:

- Requires \$4M/year to turn copper into finished product
- Can sell the product for \$10m/year
- Under the flexible contract, CUCACO can decide not to enter the 3C business, or to exit the business at the end of year 1. It cannot enter the business in the second year.

a) Draw the decision tree for this choice, giving all information provided. **(6 points)**

b) Define and calculate the value of the optimal strategy over the 2 years **(3 points)**

NOTE: for ease of calculation, you may assume no discounting for this quiz exercise.

c) Graph the Value at Risk and Gain (VARG) for the two production plans **(3 points)**

d) CUCACO is concerned about the uncertain price of copper for the second year. Before deciding about the first year, it is thinking about getting extra information that would help make the choice between the fixed and flexible contracts.

Define the concept and use of the Expected Value of Perfect Information. Calculate its value for information at time zero concerning the contract price for year 2. **(6 points)**