

ENGINEERING SYSTEMS ANALYSIS FOR DESIGN

Final Examination, 2001

Item	Points	
	Possible	Actual
Your Name	1	
1 Garbage Collection	30	
2 Optimizing Collection	15	
3 Bayesian Update	15	
4 New Product	20	
5 Deal with Manufacturer	25	
6 Market Research	20	
7 What does the boss want?	25	
Extra Credit A	10	
Extra Credit B	10	
TOTAL used for grading	150	

Your Name: _____

(1)

Note: The points for each problem and sub-problem are marked in parentheses. They correspond to the amount of time you might spend on them.

You might want to use these as a guide for how you should spend your time. Don't spend 10 minutes on a 3-point problem, for example.

You may find it worthwhile to turn to the section that is easiest for you, and to do that section first. No need to respond to questions in the order presented.

1 GARBAGE COLLECTION (30)

Assume that there are 3 ways to collect garbage. Each uses trucks and workers in different combinations. Each has its own cost and productivity. See Table below.

Collection Method	Trucks	Workers	Output (tons/hour)
"Municipal"	1	3	2.25
"High Productivity"	1	1	1.5
"Transfer Station"	3	5	6
	\$ 50/hour each	\$20/hour each	

- a) Define an isoquant (3)
- b) Determine and plot isoquant for 18 ton/hr (6)
- c) Define "marginal rate of substitution" (MRS) (3)
- d) Determine MRS along two different parts of the isoquant (6)
- e) Define Optimality Criteria in marginal analysis. Give verbal explanation of the formula (4)
- f) Apply optimality criteria to obtain best design for garbage collection system. (3)
- g) What wage rates justify the use of the "Hi-Pro" design? Assume trucks cost is fixed. (5)

2 OPTIMIZING GARBAGE COLLECTION (15)

Assume that there are 3 ways to collect garbage. Each uses trucks and workers in different combinations. Each has its own cost and productivity. See Table below.

Collection Method	Trucks	Workers	Output (tons/hour)
"Municipal"	1	3	2.25
"High Productivity"	1	1	1.5
"Transfer Station"	3	5	6
	\$ 50/hour each	\$20/hour each	

A community needs to collect 1000 tons per week. In this period it could hire (if it wanted to) up to 700 truck-hours and 1000 worker-hours. They wish to minimize their costs.

- a) Formulate as a linear programming problem. (10)
- b) Explain why this problem could (or could not) be formulated as a linear program if the cost of workers increased to \$25/hour beyond 700 worker-hours. (3)
- c) Explain why this problem could (or could not) be formulated as a linear program if the cost of trucks decreased to \$40/hour beyond 500 truck-hours (2)

3 BAYESIAN UPDATE (15)

- a) Explain what Bayes' formula does. (3)

- b) Express Bayes' formula mathematically (3)

- c) Define the likelihood ratio L_0 for the probability of an event, $P(E)$ (3)

- d) Derive the likelihood ratio L_1 using Bayes' formula (6)

4. NEW PRODUCT (20)

Your company has the choice of launching one of two products this coming season. One would be positioned in a stable market and has relatively good prospects. The other would develop a new market and is most likely either to fail or to achieve great success. See Table below.

Product Code Name	Possible Results of Product Launch -- probability and financial return		
	Failure	Good Product	Great Success
"New Model"	0.2	0.6	0.2
"Cutting Edge"	0.4	0.2	0.4
	Loss of 3 million	2 million profit	10 million profit

a) Draw decision tree for company's choice, showing all outcomes and probabilities. (6)

b) Which product is the better choice? Assume decision based on expected profit. (4)

c) Define the concept of "expected value of perfect information" (EVPI) (4)

d) Calculate the EVPI for perfect information on the outcomes of the "Cutting Edge" product (6)

5. DEAL WITH "CUTTING EDGE" MANUFACTURER (25)

See problem 4. The start-up developer of the "cutting edge" product approaches your company and proposes the following deal:

- you invest X million in a new company that would manufacture and distribute this product
- you get the right to buy this company for 1 million
- you could avoid any losses (beyond the X million already spent) --if the "cutting edge" product is a failure, the new company would go bankrupt.

a) Define "call" and "put" options. (6)

b) Draw a diagram showing the payoffs from a call option. (4)

c) Under what circumstances would you exercise the option to buy the new company? (3)

d) What is the probability that you would buy the new company, if you had the option? (3)

e) What is the value of the option, once you have paid for it? (4)

f) If the price for the option, X, is 0.5 million -- should you buy it? You still have the opportunity to assume all risks for the launch of the "cutting edge" product, as described in Problem 4 (5)

6. MARKET RESEARCH ON "CUTTING EDGE" (20)

Your company could pay 0.4 million for market research that would run test markets on the "cutting edge" product. You believe, based on your own judgement about the market (see Problem 4), that it is equally likely that they report back the "cutting edge" will be a great success or a failure. With their information, you would revise your estimate of the probability of success for "cutting edge" as in the Table below:

Market Research report says	Possibilities for "cutting edge" -- posterior probability and return		
	Failure	Good Product	Great Success
"Failure"	0.6	0.3	0.1
"Great Success"	0.2	0.2	0.6
	Loss of 3 million	2 million profit	10 million profit

a) If market research report says "failure" for "cutting edge", which product would you launch? Show calculations that justify this conclusion (3)

b) Same question as (a), if market research report says "great success." (3)

c) Define "expected value of sample information" (EVSI) (3)

d) Calculate the EVSI for the market research activity. (5)

e) Does the value of the market research justify its cost? (3)

f) Is the investment in this market research a "real option"? Discuss the question. (3)

EXTRA CREDIT B

(10)

Reflect on the computer-based exercises (1 to 6) that you did over the semester. What were the main learning points that you derived from them?