Engineering Systems Analysis for Design

Quiz on Deterministic part of course   **October 21, 2003**

This is a closed book exercise. You may use calculators

Grade Tables

There are 90 points possible for the regular test, or 1 point per minute. Points associated with each question correspond to the estimated time it might take to answer them. There are also a possible 10 points of extra credit. Final scores will be based on 90 possible points.

Item	Score	
	Max	**Yours**
Your Name (provided we can read it)	1	
Concepts	26	
What's the best design?	22	
Money, Money, Money	15	
Maximize Production	14	
Sensitivity Analysis	12	
Extra Credit	10	
Total	100	
Percentage grade on basis of 90 maximum:		

I have completed this test fairly, without copying from others, a textbook, or a web download

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

Concepts (26 points -- 2 points per part)

Write a short definition or description explaining each of the following:

Production Function

Technical Efficiency

Economic Efficiency

Isoquant

Returns to Scale

Economies of Scale

Shadow Prices

Opportunity Costs

Slack Variables

Expansion Path

Cost Function

Activities

Data Tables

What's the best design? (22 points)

You are given a production function: $6 R^{0.4} S^{0.8}$

And the cost of the resources as: $2 R^{0.5} + S^{1.5}$.

[Note: a (exp b) means "a" raised to the power of "b"]

a) What can you say by immediately, by inspection, about the returns to scale? The economies of scale? (4 points)

b) What is the optimal relationship between the resources R and S? For simplicity, provide your answer in the form of $R = K \ f(S)$ where K gathers the constant terms.   (10 points)

c) What is the associated cost function? (8 points)

Money, Money, Money (15 points)

What is Net present value?   (3 Points)

What are the major advantages and disadvantages of the Benefit/Cost ratio as a criterion of evaluation? (4)

Why might the rank order of projects change when you calculate their benefit-cost ratios using different discount rates? (4)

What are the reasons for and against using the pay-back period as an evaluation criterion? (4)

Maximize Production (20 points)

An electric power system needs to maximize power production from 3 plants (North, West and South) subject to constraints on the tons of NOx and CO2 (8 and 12 respectively)

Each plant produces NOx and CO2 in fixed proportions per unit of power produced:

Plant	Pollution Production / Unit	
	NOx	CO2
North	3	2
West	2	3.5
South	1	4

   a) Draw the isoquant for 4 units of production of power (6 points)
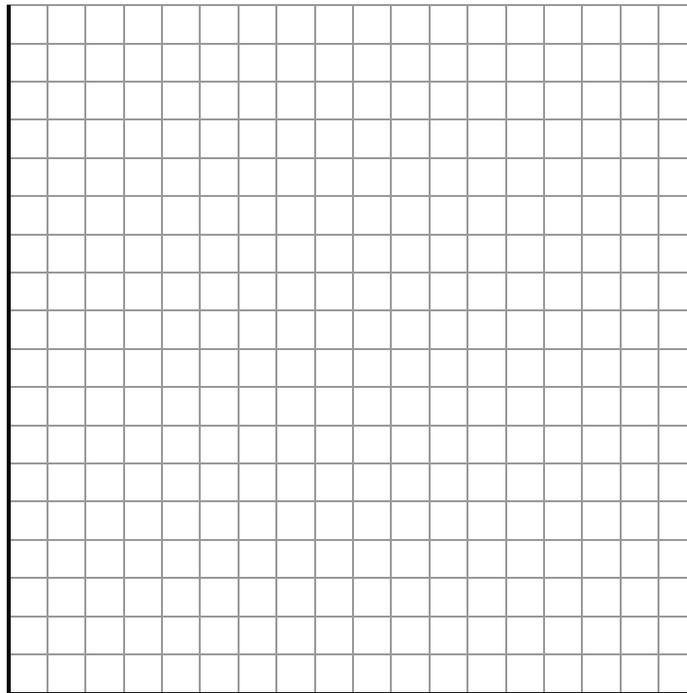
   b) Graphically define the optimum production plan (4)

c) Define the optimum production plan in terms of the amounts to be produced by each plant (5 points)

d) Set up the Linear Program. Include all necessary elements. You may use vector notation if convenient. (5 points)

Sensitivity Analysis (12 points)

Suppose you got the following results from an LP in which you were trying to minimize:

$Y = \Sigma\, c_i\, X_i$ subject to $\Sigma_I\, a_{ij}\, X_i$ greater or equal to b_j for all j

Constraint	Shadow Price	Range
B2	0	< 800
B3	30	300<......< 600
Coefficient	Opportunity Cost	
C3	0	
C4	40	

What is the meaning of the shadow price on constraint B3?   (3 points)

How do you interpret the opportunity cost associated with C4? (3 points)

What can you say about the shadow price of B3 when B3 > 600? (3 points)

What can you say about the current value of B3?   (3 points)

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For 10 points extra credit:

Think of yourself as the system designer for a major technological system. Your task is to figure out how to expand it over the next generation. Specifically, you must guide decisions about what should be done now by way of capacity addition.

Suppose that your system has economies of scale, and that, for the prevailing discount rate and long term pattern of growth you can estimate that the optimal addition would cover the next 7 years of demand.

You recognize that the future is unpredictable – what does this imply as regards the way you should design the next capacity addition to the system (4 points),

Define, as explicitly as you can, the advantages and disadvantages of the policy you propose. (6 points)