ENGINEERING SYSTEMS ANALYSIS FOR DESIGN

Mid-Semester Quiz, 2001

Item	Points	
	Possible	**Actual**
Your Name	1	
1	10	
2.1	6	
2.2	23	
3	31	
4	19	
TOTAL	90	

Your Name: _____   **[1]**

**Note: The points for each problem and sub-problem are marked in square brackets.
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 5 main questions in the order presented.

DISCOUNTED CASH FLOWS

1 <u>Explanations</u>   **[10]**

What is the proper basis for selecting a discount for an investment of government project?   [3]

Explain the principal advantages and disadvantages of benefit-cost analysis.   [4]

Explain the principal advantages and disadvantages of the payback period evaluation.   [3]

PRODUCTION FUNCTIONS

2.1 <u>Definitions</u>   **[6]**

In your own words (not copied from text), explain the notion of
a) an isoquant   [3]

b) returns to scale   [3]

2.2 <u>Paper Mill</u>   [23]

Your company runs a paper mill that uses two kinds of wood: Fir and Balsam.   Your chemical engineer tells you that the:

- marginal product of Fir is inversely proportional to the square root ($\sim 1/F^{0.5}$), and the
- marginal product of Balsam varies with the inverse ? power ($\sim 1/B^{0.25}$).

Assuming a Cobb-Douglas production process:

a) what is the marginal rate of substitution?   [6]

b) what can you say about the returns to scale of the operation?   [3]

c) Assume that the costs of Fir and Balsam are each equal to their quantity to the $5/4^{th}$ power (since more wood has to come from further away).   Determine the expansion path for increasing production.   [5]

d) Now calculate the cost function.   [6]

e) What can you say about the economies of scale for this plant?   Explain reasoning.   [3]

LINEAR PROGRAMMING

3 Plywood Manufacture [31]

Charles "Chip" Bord makes plywood from hard and soft wood using any of three processes.

Process	Board-feet of Wood		
	Input		Output
	Hard wood	Soft Wood	Plywood
1	1000	500	1333
2	1000	1850	2500
3	1000	3200	4000

Note: board-feet are measures of quantity for lumber.

Graph the isoquant for 10000 board-feet of plywood. [5]

What is the marginal product for soft wood when Chip has 1000 board-feet of hard and 3200 board-feet of soft wood? [2]

Chip finds out that process 2 is unavailable. Formulate the LP to maximize profits using processes1 and 3 if [15]
- the price per board-foot is $5 for hard wood, $3 for soft wood , and 15$ for plywood (the sales price);
- Chip could get a maximum of 200,000 board-feet of hard wood and 320,000 board-feet of soft wood from his supplier
- His machines can only process 400,000 board-feet of wood in all
- He must buy at least $1million of wood from his supplier in order to maintain favorable relations.

Suppose that if the output obtained through process 1 exceeds 4000 board-feet of plywood, process 1 changes. In case A, it (process 1) doubles, in case B it is cut in half.. Which cases (if any) can be appropriately included in the LP? Why? [3]

Show the equations you would use to incorporate the appropriate cases, if any.   [6]

SENSITIVITY ANALYSIS

4. Port Development [19]

You represent a consultant for the government of Goldenland for a proposed investment in a new port in its country. The budget for the construction is supplemented by a loan in US dollars. Otherwise the budget is in terms of the national currency of "Goldens" (G) "M" indicates millions.

Your analyst used LP to maximize the benefits of the investment. She hands you the following results:

Constraint		Shadow Price(in G)	Range
Dollar loan	$\leq$ \$200 M	15G / \$	\$150 M $\leq$ b1 $\leq$ \$220M
Probability of Oil Spill	$\leq$ 0.1%	60,000,000G / %	0.08 $\leq$ b2 $\leq$ 0.7 %
Construction Time	$\leq$ 5 years	0	3.5 $\leq$ b3
Local Workers	$\geq$ 500 workers	20000 G / worker	420 $\leq$ b4 $\leq$ 700
Port Capacity	$\geq$ 5 ships	10M G/ ship	4 $\leq$ b5 $\leq$ 6

Additionally, she reports that the Opportunity Costs for the tanker berth, the hydrofoil ferry and the pleasure marina are 150M, 30M and 20 M (in G), respectively.

Properly impressing officials from an international bank will increase the available budget by \$10M. How many G's can the nation afford to spend on a "sales effort" directed at these officials? [4]

An oil spill would cost the tourist industry 100M G's. Would it pay to relax the environmental standards? [4]

Imported skilled labor could, at some cost, speed up construction by a year. Is this idea worth pursuing?[3]

It has been suggested that the port be built to accommodate less than 5 ships and that service to excess ships be provided by barges costing 5M G's per ship served. Should you design for 4 ships? For 3 ships? What additional information might you need to explore this issue?   [5]

Under what new conditions might you agree to include the "hydrofoil ferry" option in the design of the port?   [3]