Engineering Systems Analysis for Design

Mid-Semester Quiz **October 28, 2008**

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	18	
Static valuation of projects	11	
Decision Analysis	60	
Total	90	

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

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

Concepts (18 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)**

Expansion Path **(2 points)**

Output Cost Function – define and compare with input cost function **(2 points)**

Discount Rate – define and compare with interest rate **(2 points)**

WACC – define concept and discuss advantages and disadvantages for use as discount rate **(2 points)**

Static Valuation of Project (11 points)

Consider the project with the following revenues and costs:

	Year				
	0	1	2	3	4
Revenues		300	400	600	340
Costs	1200	25	37	41	48
Net Cash Flow					
$(1+r)^N$					
Present value					

Assume a discount rate of r = 10%. Use no more than 3 significant figures

a) Define Net Present Value (NPV) 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)**

Decision Analysis (60 points)
Congratulations! You're the consultant to the UN agency about to launch satellites to provide educational resources over central Africa. Your job is to help choose the system architecture.

They face 2 choices. Either they launch 2 satellites right away, or they launch 1 with the possibility of launching a second one 5 years later. If they launch only one, they are committed to launch the second if growth in demanded educational resources in the first period is "high". Conversely, if the growth in the first period is "low", they are required to stay with only 1 satellite.

The UN education advisors estimated the possible results from the project, in terms of the number of students served in each period. They believe that:

- the first period "high" and "low" outcomes are equally likely, and
- the following second period possible outcomes are also equally likely.

Note that the actual number of students served depends on the availability of sufficient capacity in the satellite fleet.

Students Served, millions		Students Served, if no constraints			
First Period	Second Period	first	second	total	Probability
High = 120	180	120	180	300	1/4
	140	120	140	260	1/4
Low = 80	140	80	140	220	1/4
	100	80	100	180	1/4

The best estimates of cost and performance are given below. Costs are all in present values.

	2 Satellites at t = 0	1 Satellite at t = 0	2nd Satellite at t = 5
Ground Stations	30	20	10
Launches	10	10	10
Satellite	80	40	30
Total Present Costs	120	70	50
Capacity (in terms of Maximum students served)	180	100	70

Let's first examine the technology.
a) Define the concept of the returns to scale. What are they for the production of educational capacity? Show how you determined this conclusion. **(5 points)**

b) What about economies of scale? Show how you came to that conclusion **(4 points)**

c) Why is it possible to get different results for returns and economies of scale? **(3 points)**

Now proceed to the decision analysis of the situation
d) Draw the decision tree for this choice, giving all information provided. **(6 points**)
Remember, the performance of the system (in terms of number of students served) can be constrained by the satellite capacity available

e) Define and calculate the value of the strategy that maximizes the expected number of students served over the 2 periods **(6 points**)

One metric is not enough

f) Graph the Value At Risk and Gain (VARG) for the two system architectures **(8 points**)

g) Fill in the table of possible measures of performance of the system **(10 points)**

Metric	2 Satellites now	1 Satellite now	Which Preferable?
E(Students Served)			
Max Students Served			
Min Students Served			
Initial Investment			
Cost-Effectiveness = Students/investment $			

h) Now that you have the information from the VARG and the table, discuss the relative merits of the choices. Which would you recommend? Why? **(6 points)**

Value of Information
You realize that it would be nice to resolve the uncertainty about whether the demand for satellite education would be “high” or “low” in the first period.

i) Define the concept of perfect information? **(3 points)**

j) Set up the appropriate decision tree for defining the Expected Value of Perfect Information (EVPI), based on the assumption that you should focus on maximizing the expected number of students served **(6 points)**

k) Based on the above, what is the EVPI **(3 points)**