641 FINAL EXAM

1. Discuss the qualifications you would place on the use of shadow prices from

   a. Linear programming
   b. Quadratic programming
   c. Risk programming
   d. Multiple objective programming under a weighted tradeoff objective function
   e. Pure integer programming
   f. Mixed integer programming

2. Suppose you were helping someone decide how to set up a new enterprise and had formulated the model

$$
\begin{aligned}
\max \quad & \sum_j \sum_k c_{jk} \, x_{jk} & & \\
\text{s.t.} \quad & \sum_j \sum_k a_{ijk} \, c_{jk} \le b_i & & \text{for all } i \\
& \sum_j x_{jk} \le cap_k & & \text{for all } k \\
& x_{jk} \ge 0 & &
\end{aligned}
$$

   where j is activity type
   k is activity type of new enterprises

   and you now need to reflect

   a. the fixed costs of the enterprises (F_k) as well as the fact that you only get capacity (cap_k) if the fixed cost is incurred.

   b. the fact that across all the possible new enterprises (k) only 3 of them can be chosen with the rest zero.

   Modify the model accordingly.

3. Suppose you have a problem with two objectives: why might you use a lexicographic or a weighted tradeoff model?

4. Given the quadratic program

$$\max \quad cx + 1/2c'Qx$$
$$Ax \leq b$$
$$x \geq 0$$

a. Give and explain the Kuhn Tucker conditions.

b. Tell when the problem will lead to a guarantee that the solution satisfying the Kuhn Tucker conditions will be optimal.

5. Given the linear programming problem:

$$\begin{array}{llllll} \max & cX & & - gZ & - rQ & \\ & X & - dY & + fZ & - Q & \leq 0 \\ & & bY & + hZ & & \leq k \\ & & X, Y, Z, Q & \geq 0 & & \end{array}$$

where X, Y, and Z are vectors.

a. What is the nature of the demand and supply curves in the model for X, Q and the resources in the second constraint set.

b. Modify the model so it includes linear downward sloping demand curves for X, as well as upward sloping supply curves for Q and the resources in the second constraint.

c. Explain the consequences of the integrability assumptions as they affect the exogenous demand curve for X and supply curves that can be specified for Q in your answer to part b.

6. Suppose you have the problem

$$\begin{array}{lrcrcr} \max & c_1x_1 & + & c_2x_2 & & \\ & -a_1x_1 & + & a_2x_2 & \leq & 0 \\ & x_1 & + & x_2 & \leq & 100 \\ & x_1 & , & x_2 & \geq & 0 \end{array}$$

a. Structure a model under the conditions that c_1, c_2, a_1, a_2 are uncertain and each have 3 possible values (c_{ik} k=1,2,3)and (a_{ik} k=1, 2, 3). Assume all activities are decided on now but the uncertainty is resolved later.

b. When c_1 is known but a_1 can take on the values 3 or 4 with probabilities .2 and .8 and the distribution of c_2 and a_2 is as below if a_2 = 3

event	prob.	c_2	a_2
1	.3	4	2
2	.7	3	1

but equals the following if a_2 = 4

event	prob.	c_2	a_2
1	.7	7	2
2	.3	4	4

and x_2 is decided on after a_1 becomes known.

7. State the assumptions of linear programming, 2 ways to relax each of them (if there are that many) and qualifications you might place on whether the assumptions are truly relaxed by the ways you identify.