EE 590F, Homework #2, Fall 2008, Due Friday September 26, 5:00 pm

1. Below are pairs of cost functions and utility functions.
   - $C(P)=0.5P^2$ and $U(m,P)=m+\ln(P)$
   - $C(P)=e^P$ and $U(m,P)=m+2\sqrt{P}$
   - $C(P)=0.5P^4$ and $U(m,P)=m+2P(10-P)$

   For each pair,
   - Find and draw the corresponding supply and demand functions for P
   - Calculate the competitive equilibrium of the market
   - Check that the competitive allocation maximizes the social surplus
2. The department of Electrical and Computer Engineering at Iowa State University recently received an allocation of 3 parking permits for a highly desirable nearby lot, so that the department can sell the permits to staff members and then do with the money whatever it pleases. There are 6 staff members that want the spaces, but they have different willingness to pay, and different seniorities, according to the below.

Staff member	Willingness to pay	Number of years employed
1	200	10
2	190	12
3	180	15
4	180	14
5	160	16
6	150	5

   - If the department allocated the permits according to the competitive equilibrium, what would the equilibrium price and quantity be?
   - Who would buy the permits and who would not?
   - What would the consumer surplus be for each staff member?
   - What would the revenues accrued to the department be?
   - What would happen to the equilibrium if the university decided to tax the permits holders $5 per permit? Will the staff members be hurt by such a measure? Will the department's revenues change as a result?
3. Continuing problem 2, it was argued that the competitive equilibrium shows no respect for seniority, and further, the competitive price is too high. As a result, the department decided to lower the price of a parking permit to $100 and to allocate them according to seniority: staff with more seniority have priority; if a "younger" staff member wants a parking permit, s/he should wait until a more senior staff member holding a permit retires.
   - What staff members will get a permit?
   - What is the consumer surplus of each of the staff members?
   - Find a mutually beneficial trade between a permit holder & a permitless staff member.
   - Does the new seniority-based allocation mechanism result in an efficient allocation of permits?

4. Consider an electricity market on an island nation with 2 regions: North & South. Relevant data is below, with supply quantities given by q_N and q_S and demand quantities given by x_N and x_S, and all four of them given in per-unit (pu)-hour.
   - Cost function for Northern generators: $C_N(q_N)= q_N{}^2/2$
   - Cost function for Southern generators: $C_S(q_S)=4q_S + q_S{}^2/2$.
   - Utility function for Northern consumers: $U_N(m_N,x_N)=m_N+0.5(200-x_N)x_N$
   - Utility function for Southern consumers: $U_S(m_S, x_S)=m_S+0.5(100-x_S)x_S$

   a. Obtain expressions for the demand and supply functions of the economic agents in each region.
   b. Assume the Northern and Southern systems are not connected. Draw the Northern and Southern supply-demand curves on separate plots, side-by-side, and identify their respective competitive equilibria.
   c. Assume there is an infinite capacity transmission line that connects the two regions.
      i. Set up the appropriate constrained maximization problem, write down the first-order conditions, and find the solution.
      ii. What is the value(s) of the Lagrange multiplier(s) at the optimum?
      iii. What is the flow of power that is transmitted along the line? In what direction does power flow?
      iv. Find the competitive equilibrium. What is the equilibrium price?
      v. Draw the Northern and Southern supply-demand curves on separate plots, side-by-side, and show the solution obtained in (iv) on both plots.
   d. Assume the transmission line connecting the two regions has capacity of 16 pu. Answer the same questions i-v as in part c.

5. The paper by Blumsack, Ilic, and Lave, which is downloadable from the website, describes a "stylized example" in Section III. In addition to the information provided in this section of the paper, you can use the following:
   - $b_{12}=b_{34}=-10$, $b_{13}=b_{24}=-5$, $b_{23}=-5$
   - The two cost curves, which are
     $$C(P_{G1}) = 200 + 10.3P_{G1} + 0.009P_{G1}{}^2,\ C(P_{G4}) = 300 + 50P_{G4} + 0.1P_{G4}{}^2$$
     can be linearized by differentiating them. The constant terms arising in the derivatives will have no effect on the solution and so can be dropped.

   a. Modify the matlab code provided to you in the notes to compute the LMPs with circuit 2-3 out of service. Identify all network LMPs.
   b. Add circuit 2-3 and recomput the LMPs.
   c. Do your results agree with what is stated in the paper?
6. Another cap and trade system has been implemented and is described at www.rggi.org/home. Use information at this site to answer the following questions:
   a. What type of emissions does it address?
   b. When did the effort to develop this cap and trade system begin?
   c. Who administers the emissions regulations?
   d. How can power plant owners legally increase undesirable emissions?
   f. What kind of penalty is associated with violating emissions requirements ($/ton)?