Suggested Solutions
FINAL EXAMINATION
Class #30

Instructions: You have 3 hours to complete this exam. This exam is closed-book: no books or notes are allowed. In addition, you may *not* use a graphical calculator or one that stores words, user-specified functions, or spreadsheets. Answer *all* questions. Be sure to write your name and the name and number of the course on all pages that you hand in. Be as clear and legible as possible. The exam consists of 3 parts and 9 questions in total. Please note that ALL work must be shown to receive credit. The exam is out of 120 points.

Part I: Short Question and Answer Section. (Total points: 30) Please limit your response to NO LONGER than 3 or 4 sentences (take into account that each question is only worth 5 points).

1. Why do so few Cable TV franchise renewals result in a change of franchisee? What could local governments do to increase the competition for cable franchises?

Incumbent companies have an advantage in the refranchising process. They own the investments made during the previous franchise period and would have to agree terms with any franchisee, this raises the entry cost of the new firm relative to the incumbent who can treat previous investments as sunk. A standard way of avoiding this problem is to separate the ownership of the assets from the operation of the assets. Local governments could own the cables and simply franchise the right to manage them.

2. A certain government decides to auction radio spectrum for use by 3G mobile phone companies. Does it matter for the final price of mobile phone services what the government receives from the companies as a result of the auction? Justify your answer.

Auction fees are fixed costs to the companies that pay them. Prices are determined for all firms in any market by MC=MR. Fixed costs therefore do not effect price of the product. The maximum amount that any company would pay is the supernormal profit that it would gain from being in the 3G mobile phone market.

3. Under what circumstances would a regulated utility agree to move from rate of return regulation to a performance based rate making scheme (PBR)? Why might a state Public Utilities Commission (PUC) wish to propose such a change?

Rate of return regulation essentially fixes a maximum rate of return on the assets of the regulated utility and gives no incentive minimise production costs. The utility would agree to a change if it

expected this rate of return to go up. A PUC might wish to propose such a change because PBR schemes incentivise utilities to cut costs, allowing the PUC to propose a sharing arrangement whereby prices are reduced and rate of return increased as costs fall.

4. A carbon monoxide alarm costs $100 per year to fit and maintain in the US. The risk of death from carbon monoxide poisoning without an alarm is 0.00005 per year. There is a 0.8 chance that an installed alarm will detect a potentially fatal leak. While visiting the US for a year Professor Marko Tervio decides to purchase an alarm, what is his value of life? When Professor Tervio moves back to the Finland the costs and probabilities remain the same but he decides not to purchase an alarm. What might explain this decision?

*Value of life equals 100/0.00005*0.8=2,500,000. Values of life are usually a function of income, if MarkoÕs income is lower in Finland then he might well have a different monetary valuation of life.*

5. In the Californian electricity market the price of electricity increased from $30 per MWh in 1999 to $300 per MWh by the end of 2000. Electricity demand increased by 5%. Give two reasons why this situation may have come about.

Electricity supply curves can be very steep in the region of full capacity. This means that a small fall in available capacity may have a very big effect on price. Thus a decline in available capacity due to overloaded transmission links, shortage of water in hydro dam schemes in Washington State, shortage of NOX permits in the RECLAIM market or strategic withdrawl of capacity all provide explanations for the sharp rise in price.

6. The cost of a legitimate electronic music track is $1. Two billion tracks are copied per month via file sharing mechanisms and the cost of copying is free. Legitimate sales of music are $40bn dollars per year, and file sharing reduces demand by $4bn per year. What might be the value to society of strict enforcement of copyright laws over file sharing mechanisms?

*The value of illegal copies is up to 1*2*12=$24bn per year. Cost is a maximum of $4bn. Thus the benefit of illegal copies is around $20bn per year. However the benefit may be less due to the downward sloping nature of the demand curve.*

Part II: Numeric Problems. (Total points: 50). Be sure to show all of your work.

7. (25 points) A profit-maximizing company has the chance to research the cure for the common cold (CCC). If it spends $Z>1$ on R&D, then it has probability $p(Z) = 1-1/Z$ of discovering the CCC (and zero probability otherwise). Assume that the company has no other costs besides research costs, no other revenues other than those from selling the CCC if it discovers it. The present value (PV) of revenue from the CCC once discovered is $\Pi > 5$. Units for research costs, and CCC profits are

millions of dollars.

(a) How much will the company spend on research as a function of Π?

(b) What are the expected profits in terms of Π? What happens if $\Pi < 4$?

(c) Assuming no discounting, so that the PV of profits is just the sum of all future profits, and an annual profit of \$0.15 million from monopoly exploitation of CCC, what is the minimum patent length that will induce the company to do any research?

(d) Assume the patent is the length you worked out in the previous section. What is the maximum license fee the company could charge for the CCC?

7. *Innovation and patent length*

a. (6 points) The company will maximize its expected profits by choosing the level of R&D spending $Z \geq 0$. It gets a present value of profits Π with probability p(Z). Expected present value of profits is therefore $V(Z)=p(Z)\Pi-Z$. Differentiation wrt Z leads to the first order condition:

$$p'(Z)\Pi-1=(\Pi/(Z^2))-1=0$$

The solution $Z^* = \sqrt{\Pi}$

is the optimal level of R&D spending.

b. (6 points) At the optimal level of spending, Z, expected profits are:*

$$V^* = p(Z^*)\Pi - Z^* = (1 - 1/\sqrt{\Pi})\Pi - \sqrt{\Pi}$$

$$= \sqrt{\Pi}(\sqrt{\Pi} - 2)$$

This is increasing in Π for $\Pi > 1$. When $\Pi = 4$, $V^*=0$. This means that if $\Pi < 4$, then the present value of doing research must be negative, and the company would spend nothing on researching the CCC.

c. (7 points) After the patent expires anyone can produce the drug and there are no more profits. That means that for n years, the company earns 0.15 per year, where n is the patent length. The total PV of income from the CCC is 0.15n. We saw in part b) that the profits must be at least 4 for the company to break even, so the shortest patent length which lets the company

break even solves 0.15n=4, n=400/15=26.667.

d. (6 points) Once it has discovered the CCC, the NPV of profits is 0.15n=4 ($m). This is the maximum value of a license, since it is the maximum the firm buying the license could earn from selling the CCC.

8. (25 points) The demand for electricity is $Q^p=5-P^p$ in peak periods and $Q^0=4-2P^0$ in off-peak periods. Both periods take up half of each day. Variable cost is 0.25 per unit of output per period and capital cost capacity are 0.75 per unit of capacity per day. Capacity costs are sunk and cannot be adjusted between periods.

(a) Find the optimal capacity, peak price and off-peak price.
(b) With price constrained to be the same through the day, what price and capacity would maximise social surplus?
(c) Compare consumer and social surplus in the two cases.

8. Peak-load pricing: solution
This question relates to the textbook pages 379-386. It gives two cases (the firm peak case and the shifting peak case). The firm-peak case is relevant here, because the off-peak demand is low enough to not affect the optimal capacity.

a. (9 points) In the firm peak case, the peak users have to pay for all capacity costs, so their price is P^p=LRMC=0.25+0.75=1, and peak demand is Q^p=5-1=4. Capacity is always equal to peak demand (anything more would be wasted, anything less could not satisfy peak demand): K=4.
*Off-peak users will only pay for the variable costs, so P^o=SRMC=0.25 and Q^o=4-2*0.25=3.5. There will be idle capacity in off-peak periods. (If there were not then this would be the shifting peak case after all, and capacity costs would have to be shared between peak and off-peak users).*

b. (8 points) Consumer Surplus and Producer Surplus as a function of the uniform price:

$$CS(P) = (1/2)(2-P)(4-2P)+(1/2)(5-P)^2$$
$$= (3/2)(11-6P+P^2)$$
$$PS(P) = P(4-2P)+P(5-P)-0.25(9-3P)-0.75(5-P)$$
$$= 3P(3-P)-0.5(12-3P)$$

Total surplus is their sum, which simplifies into a quadratic

$$TS(P)=É=(3/2)(-P^2+P+7).$$

Taking the first-order condition, we see this is maximized at

-2P+1=0 implies P=0.5.*

*Thus peak demand and capacity are Q^p=5-0.5=4.5, while the off-peak demand is Q^o=4-2*0.5=3.*

c. (8 points) With peak-load pricing, the consumer surplus is

*(1/2)(2-0.25)(4-2*0.25)+(1/2)(5-1)^2=3.0625+8Å11.06.*

Since revenue is equal to total costs this is also the social surplus (there is no need to calculate producer surplus, we know it is zero by construction!).
With a uniform price, consumer surplus is

*(1/2)(2-0.5)(4-2*0.5)+(1/2)(5-0.5)^2=2.25+10.125=12.375.*

Consumer surplus is higher with uniform pricing only because producer surplus is now negative. It is

*PS(P)=3*0.5(3-0.5)-0.5(12-3*0.5)=-1.5,*

so social surplus is 10.875, lower than with peak-load pricing (there is too much capacity). Therefore social surplus is lower when pricing is constrained to be uniform across periods, even if the producer were allowed to make a loss.

Part III: Essay (Total points: 40).

9.ÔSenators Lieberman and McCain intend to introduce legislation early in the 108th Congress. The bill would require the Administrator of the EPA to promulgate regulations to limit the greenhouse gas emissions from the electricity generation, transportation, industrial, and commercial economic sectors as defined by EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. The affected sectors represent approximately 85 percent of the overall U.S. emissions for the year 2000. The bill also would provide for the trading of emissions allowances and reductions through the government provided greenhouse gas database which would contain an inventory of emissions and registry of reductions.Õ*Joseph Lieberman Press Release 8 January 2003*.

Discuss the rationale for this type of legislation in the light of (1) its motivation and chances of success (2) how it is supposed to work (3) any theoretical and practical weaknesses of such a tradeable permits system for greenhouse gases. Try to use specific examples and evidence drawn from the class to support your views.

The motivation for such a scheme is the idea that global warming may result in a potentially damaging change to the climate which might include higher average temperatures and sea level and

increased stress on the worldÕs ecosystem. If it were to occur global warming might result in increased deaths and direct costs of mitigation of the effects. The effects are uncertain but the expected value of them is positive and would currently justify a low, non-zero price for greenhouse gases (GHGs).

The Leiberman Ð McCain Bill has no chance of success because global warming is not just a US problem. US firms reducing emissions will create a public good of a relatively small contribution to total global warming whereas the costs will be borne by US consumers and producers via the higher price of goods which incur the permit costs. Critics will argue that the US should not go it alone in introducing such a system while major trading partners are not occurring such costs.

The scheme is supposed to work along the lines suggested by the Coase Theorem: an initial allocation of permits will lead to an efficient solution based on trading between polluters. It is supposed to work in much the same way as the SO^2 trading system in the US. Here every major electricity generation plant has to have permits equal in number to the number of tons of SO^2 it produces. The total number of permits has been reduced from the initial level of pollution such that the permits command a non-zero price. Firms abate emission of SO^2 until the marginal cost of abatement is just equal to the market price of permits. Some generators find it relatively easy to reduce emissions and hence can reduce the percentage quantity emitted by a larger amount than others. Thus the equimarginal principle is achieved by a permit trading scheme. The SO^2 scheme has been very successful in reducing SO^2 emissions and has done this much more cheaply than would have been the case under a command and control system.

Greenhouse gas emissions are more complex than SO^2 emissions. There are multiple greenhouse gases, thus some sort of index of the relative contribution to global warming of different gases would need to be specified under this scheme. If some GHGs are omitted from this there will be the potential for harmful substitution between controlled and uncontrolled GHGs. The household and agricultural sectors are omitted from the scheme. This makes sense from a transactions cost point of view but does exclude a significant group of polluters Ð there may be some scope for shifting pollution from regulated to unregulated sectors. As there are many more GHG emission sites the transactions costs of the system would be much higher than for SO^2. It may also be the case that given that the scheme will limit the quantity of emissions this may give rise to high prices, for instance in years of rapid economic growth and some production may be lost (rather like the high prices in the NOX RECLAIM market in California).