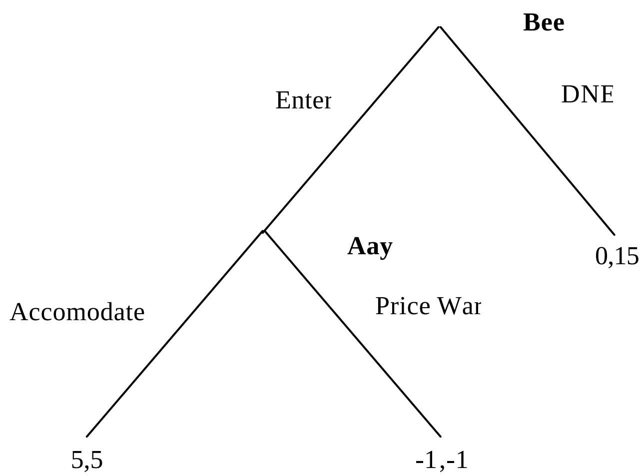
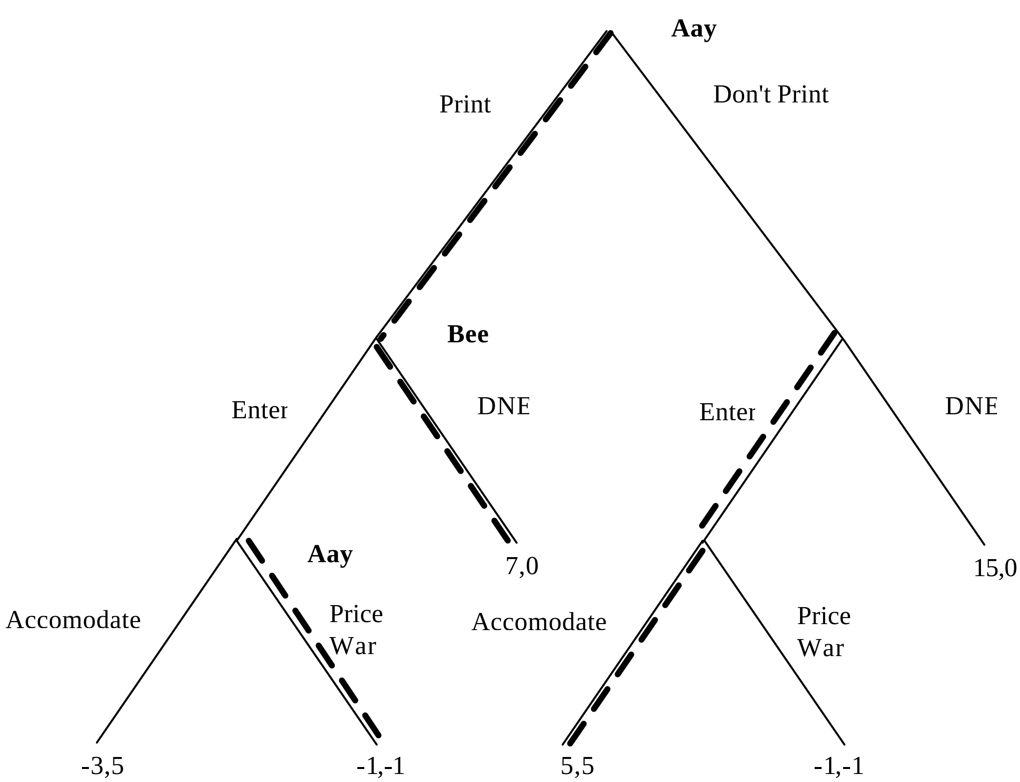
Econ 461 - Industrial Organization
Stafford, Spring 2001
Solution to Problem Set 4

1. Firm Aay operates a pool hall in Boom Town. Business has been very profitable. However, there are dark clouds on the horizon. Firm Bee is considering entering the pool hall market in Boom Town. The profits of Aay are 15 if it's a monopoly; if Bee enters and Aay accommodates and shares the market the duopoly profits are 5 for each firm; if Bee enters and Aay launches a price war, both firms earn -1.
   a) Draw the game tree for this scenario and determine the SPE.



The SPE is for Bee to Enter and Aay to Accommodate.

   b) What if launching a price war involves not only charging a low price, but printing flyers to inform the public of the great deals available? If there is a price war, both firms print flyers, and the net result of the price war is -1 for each firm (that is, the -1 takes into account the cost of printing the flyers.) Assume that Aay can have flyers printed up prior to Bee's entry decision and that the printing cost is $8. Draw the game tree for this scenario and determine the SPE.



Note that the order of the payoffs changed because in this game, Aay moves first. Now SPE strategies are marked on the game tree above as dotted lines. The net result is that Aay prints and since Aay would engage in a Price War if Bee enters, Bee does not enter.

c) What does your answer to (b) imply about the relationship between sunk costs, first-mover advantages, and entry deterrence?

Sunk costs allow Aay to make a credible threat to engage in a price war and thus deter entry. If Aay does not have the opportunity to move first and make the investment in the flyers, his threat would not be credible and thus he could not deter entry.

2. The competitive fringe's supply curve is Q = P/5. Demand is given by P = 120 - Q. The dominant firms total costs are TC = 5q.
   a) Find the equilibrium quantity and profit for the dominant firm. (Hint: follow the example on slide 10 from 4/3.)

$D_D(P)$ = D(P) - fringe supply = 120 - P - P/5 = 120 - 6/5P. (Note that the demand curve and fringe supply had to be rewritten in terms of P not q to calculate residual demand.) Rearrange this to get the inverse demand curve: Q_D = 120 - 6/5P or P = 100- 5/6Q_D. Then MR = 100 - 10/6 Q_D. Since TC = 5 Q_D, MC = 5. Set MR = MC and solve: 5 = 100 - 10/6 Q_D or Q_D = 95 * 6/10 = 57. P = 100 - 5/6*57 = 52.5. Profit = (52.5 - 5)57 = 2707.50.

   b) Suppose that the dominant firm can improve the quality of its product through a one-time investment in capital equipment. The competitive fringe can offer a similar quality product, although in doing so, its costs increase and thus the fringe supply curve decreases to Q = P/5 - 20. What is the change in the dominant firm's profit and thus, how much would the dominant firm be willing to invest to improve its quality? (Note: You should get a relatively "clean" number for the dominant firm's quantity. However the price will be a rather "dirty" decimal, as will be the change in profit.)

Now $D_D(P)$ = 120 - P - (P/5 -20) = 140 - 6/5P. Rearrange to get the inverse demand curve: Q_D = 140 - 6/5P or P = 116.7 - 5/6Q_D. Then MR = 116.7 - 10/6 Q_D. Set MR = MC and solve: 5 = 116.7 - 10/6 Q_D or Q_D = 111.7 * 6/10 = 67. P = 116.7 - 5/6*67 = 60.83. Profit = (60.83 - 5)67 = 3740.61. Change in profit, and thus willingness to invest = 1033.11 .

Exercise 15.6, parts a-c only.
Consider a homogenous product industry with inverse demand given by P = 100 - 2Q. Variable cost is given by C = 10q. There is currently one incumbent firm and one potential competitor. Entry into the industry implies a sunk cost of F.

a) Determine the incumbent's optimal output in the absence of potential competition.

In this case, the incumbent is a monopolist. Since P = 100 - 2Q, MR = 100 - 4Q. Setting MR = MC we get 100 - 4Q = 10 or Q = 22.5

b) Suppose the entrant takes the incumbent's output choice as given. Show that the entrant's equilibrium profit is decreasing in the incumbent's output.

If the entrant takes the incumbent's output choice as given, profit_{PE} = (100-2q_I-q_{PE})q_{PE} - 10q_{PE} - F. Taking the derivative of profit w.r.t. the entrant's quantity gives us: 100-2q_I -4q_{PE} -10. Rewriting, we get q_{PE} = 22.5-1/2q_I. Substituting this back into the equation for profit, we get profit_{PE} = (100-2q_I-2(22.5-1/2q_I))(22.5 - 1/2q_I) - 10(22.5-1/2q_I) - F = (45 - q_I)(22.5 - 1/2q_I) - F . To determine whether the entrant's profit is directly or inversely related to the incumbent's quantity, we take the derivative of profit w.r.t. the incumbent's quantity, which is 45 - q_I. Since this expression is negative as long as q_I is less than 45, the entrant's profit is decreasing in the incumbent's quantity as lonq as the incumbent's quantity is less than 45.

c) What output should the incumbent set to deter entry?

To deter entry, the incumbent should set a quantity large enough to make the potential entrant's profit 0, i.e., q^ so that profit_{PE} = (45 - q^)(22.5 - 1/2q^) - F = 0. Using the quadratic formula, q^ = $45 - \sqrt{2F}$.

Exercise 16.3
Two firms are engaged in Bertrand competition. There are 10,000 people in the population each of whom is willing to pay at most 10 for at most one unit of the good. Currently, both firms have a constant marginal cost of 5.

a) What is equilibrium in the market? What are firms' profits?

With identical constant marginal costs, both firms price at marginal cost (p = 5) and neither firm earns any profits.

b) Suppose that one firm can adopt a new technology that lowers its marginal cost to 3. What is the equilibrium now? How much would this firm be willing to pay for this new technology?

The new equilibrium is for the low cost firm to price at 4.99 and sell to everyone in the market and for the high cost firm to price at 5 and sell to no one. Since the low cost firm makes approximately 20,000 in this situation, the firm would be willing to pay up to 20,000 to acquire the new technology.

c) Suppose the new technology mentioned in (b) is available to both firms. The cost to a firm of purchasing this technology is 10,000. The game is now played in two stages. First the firms simultaneously decide whether to adopt the new technology or not. Then in the second stage, the firms set prices simultaneously. Assume that each firm knows whether or not its rival acquired the new technology when choosing its prices. What is (are) the Nash equilibrium (equilibria) of this game? (What does your answer suggest about why firms engage in patent races?)

The game can now be depicted as follows:

		Firm 2	
		Invest	Don't Invest
Firm 1	Invest	-10,000 , -10,000	10,000 , 0
	Don't Invest	0 , 10,000	0,0

The two Nash equilibria are: (Invest, don't Invest) and (Don't Invest, Invest). This is a classic coordination problem -- how do firms determine which equilibria will be the one chosen? For this reason, we may see patent races even though it is optimal for only one firm to invest.