1. True/False Questions (*TOTAL: 20 points*)**:**

In this section, write whether each statement is True or False. Please fully explain your answer, using a diagram if appropriate. No credit will be given for an answer without an explanation.

(a) (*5 points*) After Professor Wheaton promises that no one would fail, students never study and turn in problem sets again. This is an example of adverse selection problem.

False. It is an example of moral hazard.

(b) (*5 points*) When a firm chooses among different projects, the one which has the highest present value is always the one with the highest yield rate.

False. A big project with small yield rate might have higher present value than a small project with high yield rate.

(c) (*5 points*) If the government guarantees a binding price floor for agricultural output by purchasing any surplus, then the demand for farm labor will be more elastic.

True. With the price guarantee, firms move along their conditional demand curve, which is more elastic than the unconditional demand for labor.

(d) (5 points) Exploitation Mining Co. is the only employer in the remote town of Uranium City and pays its workers $10.00/hour. If the government forces the company to raise its wage by a small amount—say to $10.10/hour—then it will hire more workers.

True. This is just like the price regulation example we saw for monopolists, except that here the firm is a monopsonist in the market for labor. A regulated small increase in the wage will increase the quantity of labor used above the monopsony level.

(e) (*5 points*) A factory that pollutes a river has negative externalities on residents along the river. If the factory and residents can negotiate, an efficient result can be achieved only if the property right of the river is assigned to the residents.

False. According to the Coase Theorem, as long as the property right is well specified, efficiency can be achieved no matter who owns the river.

Short Question:

2. (*5 points*) A and B play rock, paper, scissors. Their payoffs are as follows (the first number is A's payoff and the second number is B's payoff):

		B		
		Rock	Paper	Scissors
A	Rock	0,0	-1,1	1,-1
	Paper	1,-1	0,0	-1,1
	Scissors	-1,1	1,-1	0,0

How many Nash equilibria are there in the game? Explain.
0 if only pure strategy Nash equilibria are considered.

Long Questions:

3. *(25 points)* Suppose that Intel has a monopoly in the market for computer chips. In order to produce *X* computer chips, it costs Intel $C(X) = 2X^2$.

(a) (*2 points*) Find the marginal cost of producing a computer chip for Intel.

Solution: $MC(X) = 4X$.

(b) (*6 points*) The demand for computer chips is $X_D = 12 - 0.25P$. Find the level of output that maximizes Intel's profits. What price is Intel charging?

Solution: We can rewrite the demand function as $P = 48 - 4X_D$, *so total revenue is* $R(X) = X(48 - 4X) = 48X - 4X^2$ *and marginal revenue is* $MR(X) = 48 - 8X$. *Equating marginal revenue to marginal cost gives*

$$4X = 48 - 8X$$
$$X_m^* = 4$$

The price is $P = 48 - 4(4) = 32$.

(c) (*4 points*) What level of output would maximize total surplus in the computer chip market?

Solution: Total surplus is maximized when price equals marginal cost. That is,

$$48 - 4X = 4X$$
$$X_{TS}^* = 6$$

(d) (*4 points*) Suppose the government knew the demand and production functions. Find a price regulation the government could impose that would induce Intel to maximize total surplus, i.e., produce the efficient quantity from part (c).

Solution: The price that gets consumers to demand 6 units is 24. If the government set a regulated price cap at $P = 24$, *Intel would face a constant marginal revenue function and would choose to produce where* $MC = 24$, *i.e., at the efficient level from part (c).*

(e) (*6 points*) If the government subsidized Intel *s* for every unit of computer chips produced, what quantity would Intel choose as a function of *s*? Find the choice of subsidy that maximizes total surplus, i.e., induces Intel to produce the efficient quantity from part (c).

Solution: Now marginal revenue is $MR(X) = 48 - 8X + s$. *If Intel equates marginal revenue to marginal cost, then*

$$4X = 48 - 8X + s$$

$$X^*(s) = 4 + \frac{s}{12}$$

The surplus-maximizing choice of subsidy induces Intel to produce the efficient number of chips from part (c). Solving for $X^*(s) = 6$, *we find that a subsidy of 24 per unit is required.*

(f) (*3 points*) Both the price regulation policy from part (d) and the subsidy policy from part (e) maximize total surplus. Is there any reason someone might prefer one policy over the other?

Solution: While the policies have the same efficiency characteristics, they have very different distributional consequences. The subsidy increases Intel's profits at the expense of taxpayers; the price regulation redistributes some of Intel's profits to consumers.

4. (*25 points*) Firm 1 and firm 2 are the only producers of spring water in the market. The market demand for spring water is given by $P = 70 - Q_1 - Q_2$. Firm 1 and firm 2 compete by choosing quantities Q_1 and Q_2 respectively. Each firm has a marginal cost of 10 and no fixed cost.

(a) *(5 points*) Find out firm 1's and firm 2's reaction functions.

Solution: $Q_1 = \frac{60 - Q_2}{2}, Q_2 = \frac{60 - Q_1}{2}.$

(b) (*5 points*) Suppose the two firms choose quantities simultaneously. What are the equilibrium price, quantities, and profits of the two firms in this market?

Solution: $Q_1 = Q_2 = 20, P = 30$

(c) (*5 points*) Suppose only firm 1 has a chance to bribe the government and get the right to choose the quantity first, what is the maximum amount of money that firm 1 is willing to pay? If firm 1 gets to move first, what are the equilibrium quantities and profits of firm 1 and firm 2? [*Hint: if firm 1 does not bribe the government, the two firms will choose quantities simultaneously as in (b).*]

Solution: The quantity of the first mover is 30 and the profit is 450. The quantity of the second mover is 15 and the profit is 225. If firm 1 does not get the right, its profit is 400. Therefore, firm 1 is willing to pay is 450-400=50.

(d) (*5 points*) Now back to the situation that the two firms choose quantities simultaneously. Suppose the two firms decide to collude and share the profit equally. Assume that both firms value their reputation and will behave according to their agreement. What are the quantities they will choose for each firm? What is the profit of each firm?

Solution: Each firm produces 15 units and gets profit 450.

(e) (*5 points*) Suppose the two firms decide to collude and share the profit equally, but both firms do not care about their reputation and might try to take advantage of the other. Foreseeing this, they make a legally enforceable contract saying that if a firm does not produce the quantity agreed, it has to pay some penalty to the other firm. What is the minimum amount of penalty that ensures each firm producing the right quantity agreed in part (d).

Solution: Given the other firm produces 15 units, the best response of a firm is to produce 22.5 units and it gets profit 506.25. Therefore the penalty should be at least 56.25 so that no one would deviate.

5. (*19 points*) The country of Economia has two industries. In the Clothing industry, the marginal product of labor is always 1. In the Steel industry, the marginal product of labor is $12L_S^{-1/2} - 2$, where L_S is the total number of workers employed in the Steel sector. The total supply of labor in Economia is fixed at $L_C + L_S = 25$, and the output price is 1 for both Clothing and Steel. *[Note on calculus: if you have forgotten, the derivative of aX^b is abX^{b-1}.]*

   (a) (7 points) Suppose that the labor market is perfectly competitive. How many workers will be employed in the Clothing sector, and how many in the Steel sector? What wage rate will workers in each sector receive? *[Hint: Workers can switch sectors at will. What does that imply about wages in the two sectors?]*

   Solution: *Workers in each sector will receive the same wage (equal to their marginal revenue product), so $w_C = w_S = 1$. This implies that $L_C = 9$ and $L_S = 16$.*

   (b) (8 points) Suppose that workers in the Steel sector form a union, which acts as a monopolist in supplying labor to the Steel industry. The union chooses a level of employment that maximizes the total wages of its members (i.e., it maximizes $w_S L_S$). How many workers will the union allow to be employed in the Steel sector? How many will now be employed in the Clothing sector? What wage rate will workers in each sector receive? [*You should assume that the prices of Clothing and Steel remain 1. The labor market for Clothing workers is still perfectly competitive.]*

   Solution: The wage rate will still be the marginal revenue product of labor, so the union maximizes $L_S(12L_S^{-1/2} - 2) = 12L_S^{1/2} - 2L_S$. Setting the derivative of total wages equal to 0, we find that

   $$6L_S^{-1/2} - 2 = 0$$
   $$L_S = 9$$

   That is, now 16 workers will be employed in Clothing and only 9 in Steel. Workers in each sector still receive their marginal revenue products, so $w_C = 1$ and $w_S = 2$.

   (c) (4 points) If workers in Clothing had unionized in order to increase their wage rate instead of workers in Steel, what would have happened to employment and wages in each sector? Explain why. [*No calculations necessary; just describe the outcome qualitatively.*]

   Solution: Nothing. Workers in the Clothing sector can't raise wages at all—Clothing firms have a perfectly elastic demand for labor!