PROBLEM SET 1 (due Thursday March 22nd)

1. Fill in the following table:

Quantity of Labor	Quantity of Output	Marginal Product of Labor	Average Product of Labor
0	0	—	—
1	3		3
2		4	3.5
3	10		
4			3

When does diminishing marginal returns set in?

2. Kike and Fátima are starting a new restaurant in Teruel. While Kike plans to do the cooking himself, he will need to employ workers and machinery to produce food. He estimates his production function as:

$$q = 15L^{1/4}K$$

Kike is able to accumulate €10,000 to finance the business. Workers cost €10 and capital costs €50.

a) If Kike wishes to produce the most output with the finances available, how much labor and capital should Kike employ? Use a Lagrangian to solve this problem.

b) Does this bundle of capital and labour also minimize the costs? Explain using a graph.

3. A firm uses labour and machines to produce output according to the production function $f(L,M) = 4L^{1/2}M^{1/2}$, where L is the number of units of labour used and M is the number of machines. The cost of labour is 40€ per unit and the cost of using a machine is 10€.

a) Draw an isocost line for this firm, showing combinations of machines and labor that cost 400€ and another isocost line showing combinations that cost 200€. What is the slope of these isocost lines?

b) Suppose that the firm wants to produce its output in the cheapest possible way. Find the number of machines it would use per worker.

c) Calculate the amount of labour and the number of machines that are used to produce 40 units of output in the cheapest possible way, given the above factor prices. What is the minimal cost of producing 40 units of output?

d) How many units of labour and how many machines would the firm use to produce y units in the cheapest possible way? How much would this cost? [i.e. calculate the cost function]

4. Suppose a firm must pay an annual tax, which is a fixed sum, independent of whether it produces any output.
a) How does this tax affect the firm's fixed, marginal, and average costs?
b) Now suppose the firm is charged a tax that is proportional to the number of items it produces. Again, how does this tax affect the firm's fixed, marginal, and average costs?

PROBLEM SET 2 (due Thursday 24th May)

1. Suppose that a firm's production function is $q= 9x^{1/2}$ in the short run, where there are fixed costs of 1,000€ and x is the variable input, whose cost is 4,000€ per unit.
a) What is the total cost of producing a level of output q. In other words, identify the total cost function C(q).
b) If price is 1000€, how many units will the firm produce? What is the level of profit? Illustrate on a cost curve graph.

2. A monopolist faces an inverse demand given by $p = 400 – 4Q$, and its marginal cost is constant and equal to 200.

a) Calculate the deadweight loss of this monopoly.
b) If the monopolist were charged a €100 per unit tax, by how much would price increase? Represent graphically parts a-b.

3. Consider a duopolistic market for a homogeneous product. Inverse demand is given by $P = 31 – 2 (y_1 + y_2)$. The marginal cost of firm 1 is $c_1=5$ whereas the marginal cost of firm 2 is $c_2=3$.

a) Calculate the Cournot equilibrium (i.e., the values of y_1 and y_2 for which both firms are doing as well as they can given their competitors' output). What are the resulting market price and profits of each firm?

b) Calculate the Stackelberg equilibrium. What are the resulting market price and profits of each firm? Represent parts a) and b) in reaction function space.

c) What do consumers prefer, the Cournot equilibrium or the Stackelberg equilibrium? Why?

4. Suppose that two identical firms produce watches and that they are the only firms in the market. Their costs are given by $C_1 = 60Q_1$ and $C_2 = 60Q_2$, where Q_1 is the output of Firm 1 and Q_2 the output of Firm 2. Price is determined by the following demand curve: $P = 300 – Q$, where $Q = Q_1 + Q_2$.

a) Suppose the two firms form a cartel to maximize joint profits. How many watches will be produced? Calculate each firm's profit. Compare with the solution under monopoly.
b) Returning to the duopoly of part (a), suppose Firm 1 abides by the agreement, but Firm 2 cheats by increasing production. How many watches will Firm 2 produce? What will be each firm's profits?