Homework Policy:

Study You can study the homework on your own or with a group of fellow students. You should feel free to consult notes, text books and so forth.

The quiz will be available Wednesday at 5pm. Following the Honor code, you should find 20 minutes and do the quiz, by yourself and without using any notes. Paper and pen should be all you need. Then turn it in by Thursday 5pm. (drop off in box in front of Baxter 133). It will include one question from each section

The answers to the whole homework will be available Friday at 2pm.
Definitions
Please explain each term in three lines or less!

- Market imperfection
  A market imperfection or failure occurs when impediments are imposed on otherwise efficiently functioning markets, resulting in an inefficient allocation of goods in that market. In such settings, individuals’ self-interested behavior leads to results that are inefficient.

- Externality
  Any effect of an action or decision (e.g., purchase, use) by one set of parties on others who were not involved in the action and whose interests were not taken into account. Typical example: pollution.

- Pigouvian tax
  Is a per-unit tax levied on goods generating negative externalities equal to the marginal externality at the socially efficient quantity in order to correct the market outcomes. The tax levied is equal to the difference, at the socially efficient quantity, between the marginal social cost and the marginal private cost. With the addition of the tax, the new supply curve intersects demand at the socially efficient quantity.

- Monopoly power
  Refers to the capacity of certain firms to increase the price of their products above marginal costs and sustain sales for a long period of time. Firms enjoying monopoly power are those that face downward sloping demand curves.

- Natural monopoly
  A natural monopoly occurs when the entire market can be efficiently served by a single firm because economies of scale determine that average costs are lower with one firm than with multiple firms.

- Price discrimination
  Price discrimination takes place when a firm charges different consumers different prices for identical goods (services). In order to be able to “price discriminate”, the seller must be able to identify the demand of different groups of customers and prevent arbitrage (intermediation).

- Public good
  A public good is a good with two characteristics: non-excludability (i.e., the producer can’t prevent the use of goods by others) and non-rivalry (that is, many consumers can use the same good simultaneously).

- Free rider problem
The term refers to the individuals who don’t contribute (to the provision of public good) and “free-ride” on the contributions of others. Given the characteristics of public goods, individuals can take advantage of them without contributing sufficiently to their provision. Individuals’ incentives to contribute is in fact reduced by the contributions of others, and will tend to be smaller when the group is larger.

Word problems

- Indicate which of the following statements (referred to the figure below) is true:
  1) In the absence of government intervention, the quantity of “pollution” produced will be
     a) 45 tons
     b) 40 tons
     c) 20 tons
     d) 30 tons.
     Answer: a
  2) If the government established and environmental regulation that did not allow the quantity of pollution to exceed 30 tons, there would be:
     a) Too little pollution, because the marginal social benefit of pollution would exceed its marginal social cost
     b) Too much pollution: pollution is an “economic bad”, and any quantity is thus socially inefficient from an economic perspective
     c) A socially optimal quantity.
     d) Too much pollution, because its marginal social cost would exceed its marginal social benefit.
     Answer: c
The figure below shows the marginal cost and benefit of pollution. If the current level of pollution is at Q₁, indicate which of the statements below is true:

a) The optimal amount of pollution is being produced.

b) Not enough pollution is being produced.

c) Too much pollution is being emitted.

Answer: b, since at Q₁, the marginal social benefit of pollution exceeds the marginal social cost.
• Indicate whether each of these goods is a public good, and explain why/why not.
  
a) University education
  
  It is not a public good – it is a private good with positive externalities. A public good has two characteristics: it is non-excludability and non-rivalry. University education is excludable, since students have to pay to attend even public universities. It is also rival in certain sense: an additional student implies that the professor will be able to devote less time on the students already there.

b) Pay-per view TV show.
  
  It is not a public good, since it is obviously excludable: people are charged to watch the show, and those who do not pay, are prevented from watching it. It is non-rival, though.

c) City streets.
  
  City streets are always non-excludable, but can be rival or not depending on the time of the day (e.g., when it is congested/not congested).

• Suppose that a firm dumps wastes into a river, decimating the fish population and reducing the profits of the fishermen living along the river by $100,000 a year. The cost of eliminating the wastes for the firm is $60,000 a year.
  
  a) Using the notion of Coase bargaining, explain how costless bargaining between the firm and the fishermen will lead to a socially efficient outcome, regardless of whether the firm or the fishermen own rights on the river.

  If the firm is assigned property rights, the fishermen will pay $60,000 to the firm to eliminate the toxic waste. If, on the other hand, property rights are assigned to the fishermen, the chemical producer will clean up the waste, because this is cheaper than compensating the fishermen. Therefore, regardless of who property rights are assigned to, the toxic waste will be cleaned up because this is less costly than the damage.

  b) How would the answer to a) change if the waste reduced the fishermen's profits by $40,000 a year, but the firm could only eliminate the waste at a cost of $60,000 per year.

  If the fishermen’s profits were reduced by $40,000 and property rights were assigned to the firm, the fishermen would not find it worthwhile to pay for cleanup. The fishermen will receive no compensation. If property rights are assigned to the fishermen, the firm would compensate the fishermen $40,000 rather than paying the cleanup cost. Thus, no matter whom property rights are assigned to, the waste will not get cleaned up. This is still economically efficient because cleanup costs more than the damage.

• Indicate whether each of these sentences is true or false, briefly justifying your answer.
  
a) A monopolist operating in two markets and facing the same production costs to serve both of them must charge a higher price in the market with higher price-elasticity.

  False. It must charge a higher price in the market with lowest price-elasticity. This can be seen from the first-order profit-maximization condition for the monopolist:
\[ \pi(q) = p(q)q - c(q) \Rightarrow \frac{\partial \pi}{\partial q} = p'(q)q + p(q)c'(q) = 0 \]

\[ \Rightarrow p(q) - c'(q) = -qp'(q) \]

\[ \Rightarrow \frac{p(q) - c'(q)}{p(q)} = \frac{1}{\epsilon} \]

\[ \Rightarrow p(q) = \frac{\epsilon}{1-\epsilon} c'(q) \]

Thus, a monopolist marks up the marginal cost by the factor \( \frac{\epsilon}{1-\epsilon} \) when \( \epsilon > 1 \). Since \( \epsilon \) is a decreasing function of \( \epsilon \) for \( \epsilon > 1 \), it follows that a monopolist will charge a higher markup over marginal cost to consumers with less elastic demand than to consumers with more elastic demand.

b) A monopolist operating in two markets and facing the same production costs to serve both of them must charge a higher price in the market with a higher demand.
False. The notion of “higher demand” has no place here. What matters is the price-elasticity of demand, as seen in a).

c) A monopolist operating in two markets and facing different marginal costs to serve each of the markets will always charge a higher price in the market associated with higher marginal costs.
False. A monopolist will maximize profits by equating marginal revenue to marginal cost in each market. If price elasticities differ in the two market, it is not necessarily the case that the market with a higher marginal cost will have to face a higher price. See also a).

**Technical problems**

- Assume that a monopolist with total cost function \( c(q) = q^2 + 100q \) faces a market demand curve given by: \( q^d = 700 - p \).
  a) Obtain the optimal production level, price, and profit level for the monopolist.
  The monopolist’s profits are given by: \( \pi = p(q)q - c(q) = (700 - q)q - q^2 - 100q \). First-order profit-maximization conditions lead to: \( \frac{\partial \pi}{\partial q} = 700 - 2q - 2q - 100 = 0 \Rightarrow q^* = 150. \)
The monopolist thus charges the price: \( p^* = 700 - q^* = 700 - 150 = 550 \), and his total profits are: \( \pi = 550 \cdot 150 - 150^2 - 100(150) = 45,000 \).

b) Suppose that the government establishes a fixed tax of 10,000 dollars. How does this tax scheme affect the production and profit levels of the monopolist?
Since the tax is fixed, the production level and price obtain in a) do not change. Only profits vary, and now become: \( \pi^* = 550 \cdot 150 - 150^2 - 100(150) - 10,000 = 35,000 \).

c) Suppose now that, instead of a fixed tax, the government now establishes a 20 dollar tax per unit sold of the good. How would this tax affect the production and profit levels of the monopolist?
The per-unit tax faced by the monopolist can be thought of as an increase in his costs; the monopolist’s total cost functions could thus be rewritten as: 
\( \tilde{c}(q) = q^2 + 100q + 20q = q^2 + 120q \). Solving analogously as in part a), we get: 
\( q^* = 145, \ p^* = 555, \text{ and } \pi^* = 42,050 \).

d) How would the monopolist’s production level, price and profits change if instead the government established a 10% tax over the firm’s revenues.
With a 10% revenue tax, the monopolist’s profits would be given by: 
\( \pi = p(q)q - c(q) - 0.1p(q)q = 0.9p(q)q - c(q), \) which, given the demand and cost functions faced by the monopolist, become: 
\( \pi = 0.9(700 - q)q - q^2 - 100q \).

Following the same reasoning as in the previous parts, we get: 
\( q^* = 139.47, \ p^* = 560.53, \text{ with profits equal to 44,778.23 (before taxes) and net profits (after taxes) of 36,960.53.} \)

e) Which of the three previous tax schemes would consumers prefer?
They would clearly prefer the fixed tax scheme in part b).

- Assume a monopolist sells the same good in two different markets. The aggregate demand in market 1 is \( q_1^d = 200 - p_1 \), while for market 2, the aggregate demand is \( q_2^d = 50 - \frac{1}{2}p_2 \). The marginal cost of production for the monopolist is constant and equal to 40.

a) What would be the equilibrium prices and quantities in each market if the monopolist behaved as a price-taker in both of them?
Since the monopolist behaves as a price taker, the price it charges equals its marginal cost. Hence, in each of the markets, the equilibrium price would be $p^* = 40$.
From the demand functions in each of the markets, we get that: $q_1^* = 160$, $q_2^* = 30$.

b) Now assume that the firm behaves as a price-discriminating monopolist. What would be the prevailing prices and quantities transacted in each market?
The monopolist’s profits in market $i$, $i = 1, 2$, are given by: $\pi_i = p_i(q_i)q_i - c(q_i)$. Hence:
$\pi_1 = (200-q_1)q_1 - 40q_1$
$\pi_2 = (100-2q_2)q_2 - 40q_2$
Since the firm’s marginal costs are 40, its’ total costs are $40q_i$.
So, from the first-order profit maximization condition, we get:
$\frac{\partial \pi_1}{\partial q_1} = 200 - 2q_1 - 40 = 0 \Rightarrow q_1^* = 80 \Rightarrow p_1^* = 120$
$\frac{\partial \pi_2}{\partial q_2} = 100 - 4q_2 - 40 = 0 \Rightarrow q_2^* = 15 \Rightarrow p_2^* = 70$

c) Draw the demand (D), marginal revenue (MR) and marginal cost (MC) function for each market resulting from part b).

d) Now suppose that the government precludes the monopolist from charging different prices in the two markets. What price would the firm - acting as a monopolist - then charge in the “unified” market?
Note that, if \( p \geq 100 \), only the first group of consumers, i.e., those with aggregate demand \( q^d = 200 - p \), will demand positive quantities of the good. In contrast, for \( p < 100 \), both groups of consumers will demand positive quantities of the good. Hence, the aggregate demand function in this “unified” market will be:

\[
q = \begin{cases} 
200 - p & \text{if } p \geq 100 \\
200 - p + 50 - \frac{1}{2} p = 250 - \frac{3}{2} p & \text{if } p < 100
\end{cases}
\]

The marginal revenue \( MR \) (i.e., the derivative of revenue \( p(q)q \) with respect to \( q \)) will thus be:

\[
MR = \begin{cases} 
\frac{\partial (200 - q)q}{\partial q} = 200 - 2q & \text{if } q \leq 100 \\
\frac{\partial (500/3 - 2/3 q)q}{\partial q} = \frac{500}{3} - \frac{4}{3} q & \text{if } q > 100
\end{cases}
\]

From here, we see that \( MR = MC \) only for \( q \leq 100 \), in which case: \( q^* = 80 \), \( p^* = 200 - 80 = 120 \). Only one of the two markets (comprising consumers from group 1) will be served by the firm.