Massachusetts Institute of Technology

Department of Economics

14.01 Principles of Microeconomics

Exam 2

Tuesday, November 9th, 2010

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Instructions. Please read carefully.

The exam has a total of 100 points. Answers should be as concise as possible. This is a closed book exam. You are not allowed to use notes, equation sheets, books or any other aids. You are not allowed to use calculators. You must write your answers in the space provided between questions. Fractional answers are permissible in any part of this exam. DO NOT attach additional sheets of paper. This exam has 18 pages (13 pages + 5 blank pages for scratch work)

Circle Your Section/Recitation:

Please circle the section or recitation, which you are attending below. The marked exam will be returned to you in the section or recitation that you indicate.

MWF 9AM

MWF 11AM

MWF 1PM

MWF 2PM

[✓ F 10AM]

F 11 AM

F 1PM

F 3PM

DO NOT WRITE IN THE AREA BELOW:

Question 1 11/16

Question 2 13/22

Question 3 17/27

Question 4 20/35

Total 61/100

B+

1. True/False/Uncertain Questions (16 points)

In this section, write whether each statement is True, False or Uncertain. You should fully explain your answer, including diagrams where appropriate. Points will be given based on your explanation.

(a) (4 points) Two firms are producing similar goods, but one enjoys economies of scale and one has diseconomies of scale. Claim: both firms can have an identical long-run linear expansion path.

~~No~~/False. The firm with diseconomies of scale must put more resources into producing a higher output level than the firm with economies of scale, who will increase production and produce more efficently.

-4

The expansion path shows what resources are needed as firm expands

Well both are the same linear curve (would you consider that true) but spaced at more

(b) (4 points) A firm is currently earning negative profit on each good it produces. Claim: it is always optimal for this firm to shut down in the short run.

No/False. The firm loses money if $P < ATC$ but because of its fixed cost investment it will not shut down until $P < AVC$ when it does not make sense to continue operations.

(c) (4 points) The market for drug production is characterized by both lengthy periods of patent protection and the need for FDA permission to market products. Claim: this market will be characterized by production at the minimum level of average cost in the long run.

False. This is ~~similar to~~ is a monopoly market where the firm will produce at MR = MC, to avoid the "poisoning effect". If the firm was competitive it would produce to minimize LRATC

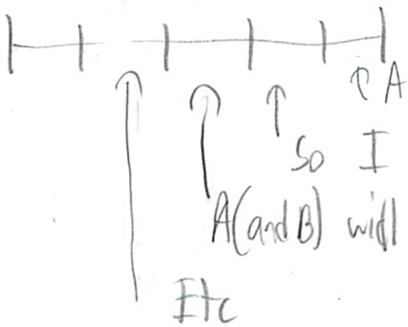
Uncertain

①

(d) (4 points) Cooperative behavior between two oligopolists is impossible if they know that they will be competing for a limited number of years.

True in theory. Each one will believe that the other will cheat just before the end, so each firm will preemptivly cheat each period of time into the present.

Example Say time = 5 years



A (and B sepertly) say B (and A) will cheat here

So I will cheat here pre-emptivly

A(and B) will cheat here, so I need to pre emptivly cheat

Etc

Oh piecewise - mixing it up!

(eval for each one, use best(

2. Costs and profit maximization (22 points)

A profit-maximizing, price-taking firm produces output Y using a single input X. The firm can produce ~~0, 8, 9, or 15 units of Y by using 0, 4, 7, or 9~~ units of X, respectively. There are no other possible input-output combinations. The firm's production function is therefore given by:

Use

$$Y = f(X) = \begin{cases} 0 & \text{if } X = 0 \\ 8 & \text{if } X = 4 \\ 9 & \text{if } X = 7 \\ 16 & \text{if } X = 12 \end{cases}$$

Can only produce at one outcome

The price of input X is 1 dollar per unit.

✓ (a) (4 points) Write the firm's total cost as a function of output.

$$C = p \cdot X = \begin{cases} 0 & X=0 \\ 8 & X=4 \\ 9 & X=7 \\ 16 & X=12 \end{cases}$$

If

$$MC = \begin{cases} 8/4 = 2 & 0 \to 4 \\ \frac{9-8}{3} = \frac{1}{3} & 4 \to 7 \\ \frac{16-9}{5} = \frac{7}{5} & 9 \to 12 \end{cases} \qquad AC = \begin{cases} 0 & X=0 \\ 2 & X=4 \\ 9/7 & X=7 \\ \frac{16}{12} = \frac{8}{6} = \frac{4}{3} & X=12 \end{cases}$$

(b) (6 points) Find the firm's supply function $y(p)$. Explain your answer.

-5

It supplys at a level to minimize ATC - or where $p = MC = AC$

So at aput level 4 $MC = AC = 2 = p$ $\quad q = 4$

It is the MC curve above $p = AVC$ ✓

(Seems like mor

✗

-4

(c) (5 points) Suppose that there are 5 such price-taking firms in the market, and that there is no entry. Market demand is given by $Q_D = 100 - 10p$. What is the equilibrium price and quantity in this market? ?

So for each firm the AC = MC output q = 4

There are 5 firms so market supply is $4 \cdot 5 = 20$?

$Q_D = 100 - 10p) = Q_S = 20$

$-20 = 100 - 10p$

$-20 \quad +10p$

$80 = 10p$

$p = 8$

$q = 4 \quad p = 8$

$Q = 20$

✓ (d) (7 points) Suppose now that instead of the 5 firms in part (c) there is actually a single monopolist that is five times as large as one of these individual firms. The monopolist's production function is therefore:

↓ input price

$$Y_M = 5 \cdot f(X_M) = \begin{cases} 0 & \text{if } X_M = 0 \\ 40 & \text{if } X_M = 20 \\ 45 & \text{if } X_M = 35 \\ 80 & \text{if } X_M = 60 \end{cases}$$

$p(x) = 1$ still

$P = 10 - \frac{Q}{10}$

$10P = 100 - Q$

$\overset{2}{45} \times 5.5 = 22.5 + 205.0 = 225.5$

180

$\overset{1}{42} \times 5.7 = 29.4 + 210.0 = 239.4$

Demand is given by $Q_D = 100 - 10p$ as before. Assume now that entry is once again impossible. What is the equilibrium price and quantity in this market? Compare this outcome with the equilibrium in (c) and explain why they are the same / differ.

MR = MC

$R = P \cdot Q$

$= Q\left(10 - \frac{Q}{10}\right)$

$= 10Q - \frac{Q^2}{10}$

$MR = 10 - \frac{1}{5}Q$

$$C = \begin{cases} 0 & X_m = 0 \\ 40 & X_m = 20 \\ 45 & X_m = 35 \\ 80 & X_m = 60 \end{cases}$$

$$MC = \begin{cases} \frac{40-0}{20} = 2 & X_m = 20 \\ \frac{45-40}{35-20} = \frac{5}{15} = \frac{1}{3} & X_m = 35 \\ \frac{80-45}{60-35} = \frac{35}{25} = \frac{7}{5} & X_m = 60 \end{cases}$$

$10 - \frac{Q}{5} = 2$

$8 = \frac{Q}{5}$

$Q = 40$

$P = 10 - \frac{40}{10} = 6 \quad TC = 40$

$\pi = P \cdot Q - TC$

$40 \cdot 6 - 40$

200

$10 - \frac{Q}{5} = \frac{1}{3}$

$9.6 = \frac{Q}{5}$

~ 45

$P = 5.5 \quad 45$

$45 \cdot 5.5 - 45$

180

$10 - \frac{Q}{5} = \frac{7}{5}$

$\frac{Q}{5} = 8.5$

$Q \approx 42$

$P = 5.7 \quad 60$

239.4 ← best outcome!!!

$R = P \cdot Q$

$= (100 - Q)Q$

$= 100Q - Q2$

$MR = 100 - 2Q$

$C = 20Q$

$MC = 20$

$MR = MC$

$100 - 2Q = 20$

$80 = 2Q$

$\boxed{Q_m = 40}$

$P_m = 100 - 40$

$\boxed{P_m = 60}$

Competitive

$P = MC = AC$

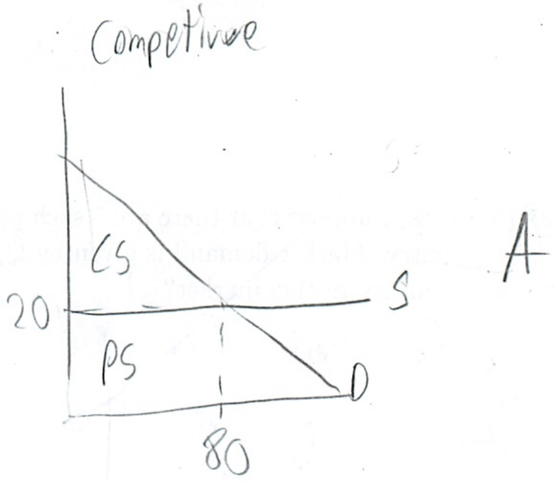
$\boxed{P_c = 20}$

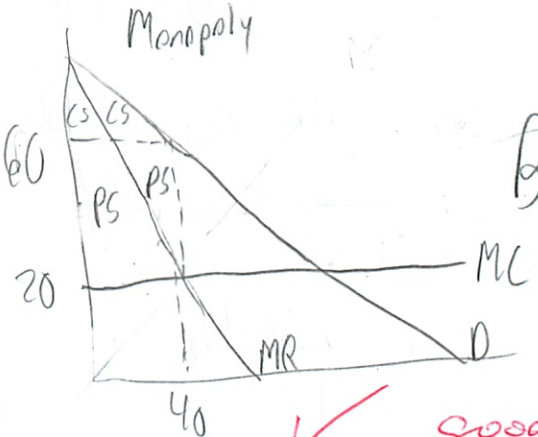
$\boxed{Q_c = 80}$

$C = 20(40)$

$= 800$

$AC = \frac{20Q}{Q} = 20$





✓ good!

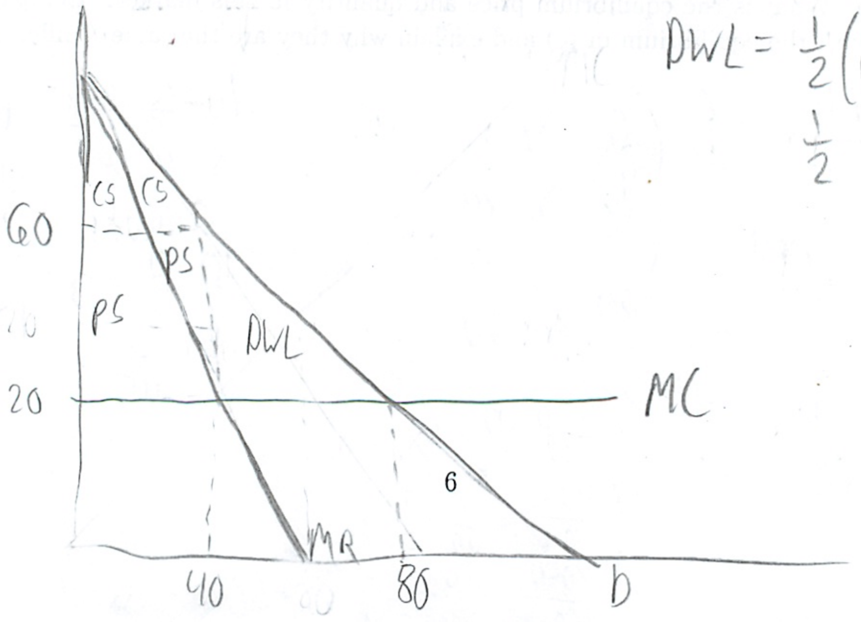
3. Monopoly and oligopoly (27 points)

A uniform pricing monopolist has the following cost function and faces the following demand curve for its product

$$C(Q) = 20Q$$
$$P = 100 - Q$$

(a) (3 points) Find the monopolist quantity (Q_m), price (P_m), and deadweight loss relative to the perfectly competitive outcome. Draw a diagram labeling the perfectly competitive outcome as A, and the monopolist outcome as B. Be sure to include the marginal cost and marginal revenue curves in your diagram.

M



$DWL = \frac{1}{2}(60-20)(80-40)$

$\frac{1}{2}\, 40 \cdot 40$

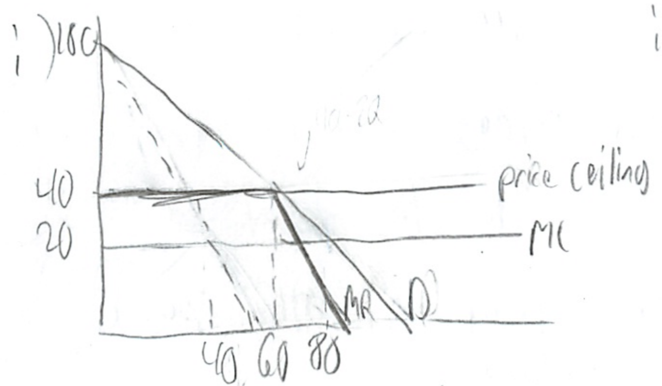
800

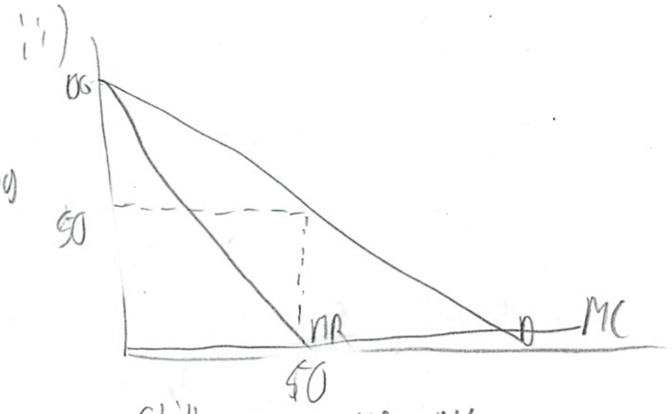
(b) (6 points) There are two possible scenarios for the monopolist:

(i). The government set a price ceiling of \$ 40/unit in which case the monopolist does not invest in any R & D because it is wary of future government regulation.

(ii). There is no government regulation, so then the monopolist invests in R & D which then changes the cost function so that $MC = 0$.

Which scenario has higher welfare (ignore the cost of R & D for producer surplus)? Which scenario do the consumers prefer? Explain.





Produces where MR = MC

★ change In this case it produces at the competive level

← consumers porfer

(-1)

P = 40

Q = 100 - 40 = 60

CS = ½ · 60 · 60 = 1800

PS = 20 · 60 = 1200

TW = 2400 3000

↑ but lower total welfare

Still when MR = MC

or when MR = 0

100 - 2Q = 0

2Q = 100

Q = 50

P = 50

CS = ½ 50 · 50 = 1250

PS = 50 · 50 = 2500

TW

3750

↑ higher total welfare

since company earning a lot more profits - ~~at~~ still constricts output in order to keep price high - bad for consumers

(c) (6 points) For plan (i), the MR curve features a discontinuity at some Q'. Explain intuitively why the MR curve has this discontinuity.

Where does it kink?

Because when the government has placed the price cap, they force the monopolist to charge a lower price than he otherwise would, thus removing the "poisoning effect" that he would have otherwise felt. After the marginal WTP (demand) falls below this price, the poisoning effect is back, and MR is back to its normal self.

(d) (6 points) In scenario (ii), when $MC = 0$, the monopolist chooses (Q_m, P_m) such that $|\epsilon^D| = 1$. Will an unregulated uniform pricing monopolist ever choose (Q_m, P_m) such that $|\epsilon^D| < 1$? Explain intuitively.

+6

No, they want to get to the point where raising the price (which causes q to ↓) balances out and revenue is not affected. This is where revenue is maximized, otherwise they could ↑ or ↓ q to get to this point (assuming the AC is below price at this point)

↑ exception that would make it false

(e) (6 points) Go back to your solution in (a). Suppose now the government allows one other identical firm to enter this market and firms compete on quantity. Let x equal the value of the MR at the monopolist output when there's only one firm. Claim: If the two firms each produce half the monopoly quantity, then $MR = x$ for both firms at current levels of output. Is this claim true, false, or uncertain? Please explain your reasoning.

-3

Cooperation can't be sustained.

True - marginal revenue will be the same if they cooperate and split the market. It is uncertain because the firms have an incentive to cheat the other firm in the oligopoly. If they do not cooperate, their MR would be lower - but still higher than it would be at perfectly competitive

? bit confused w/ all effects
something fishy

1
49
12
98
1 490
588

1200
-588
722

1190
-490
600

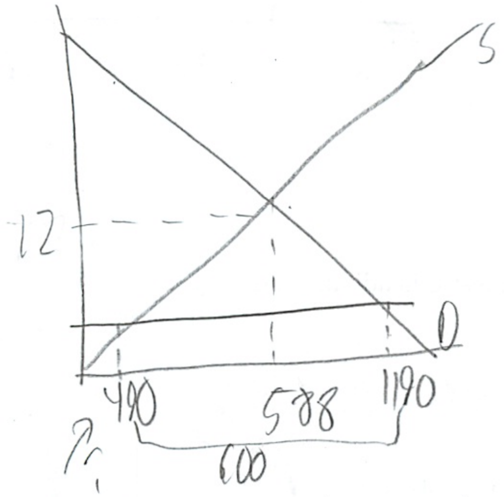
4. Trade in sweat-trapping headbands (35 points)

The U.S. demand for sweat-trapping headbands is summarized by the function $q_d = 1200 - p$, where p is the market price of a headband. There are currently 49 identical, profit- maximizing domestic headband producers in the U.S., each with the cost function $TC(q) = 72 + 0.5q^2$. U.S. consumers consider domestically produced headbands to be identical to foreign-produced headbands, and currently have access to a huge supply of foreign-made handbands at a constant price of $10 per band (that is, we can think of the worldwide supply of sweat-trapping headbands as a horizontal curve at $p = 10$).

① → ② → ... Reading Order

(a) (5 points) Write down an expression for the supply curve for an individual domestic headband producer. If there is perfectly free international trade in sweat-trapping headbands, what will be the market price of a headband in the U.S.? How many headbands will be purchased in the U.S.? How many of those will be imported from abroad?

-3



$Q_D = Q_S$?

Each firm produces where $p = MC = AC$

① $MC = .5 \cdot 2q = q$

$AC = \frac{72}{q} + .5q$

$MC = AC$

$q = \frac{72}{q} + .5q$

$-.5q = \frac{72}{q}$

$-.5q^2 = 72$

$q^2 = \frac{72}{-1/2}$

$q^2 = -144$

$q = 12$

$Q_S = 49 \cdot 12$

$= \boxed{588}$

? at any price - since 49 firms in market

② ~~$Q_D = 1200 - p$~~

~~set = to $Q_S = Q_D$~~

~~$588 = 1200 - p$~~

~~$p = 722$~~

$p = 12$? ~~seems really wrong~~ ~~not a good Qs~~

well international trade

$Q_D = 1200 - 10 = 1190$

~~World supply = 1190 - 588~~

~~= 712~~

⑤ Now (SR) at $p = 10 = MC = q$

$q = 10$ is most efficent

So US supply = 490

imports = 600

④ ?
how many
should be supplied by us markets?

0 - because lowest ATC for US producers is 12

All firms will go out of biz

all 1190 sweat bands imported in long run,

③ AVC producer $= \frac{.5q^2}{q} = .5q = 6$

AC producer

$\frac{72}{12} + .5q$

$6 + 6 = 12$

TC for each producer = $72 + .5(12)^2$

144

(b) (5 points) What will be the profits of each domestic headband producer? What will be the total profits earned by firms in the U.S. domestic headband industry? Assume, for now, that the number of domestic producers remains fixed at 49. Illustrate your answer with two diagrams: one showing the profit-maximization decision of an individual domestic firm, the other showing the entire U.S. headband industry.

-4

~~Giant~~ losses

Each firms TC = 144

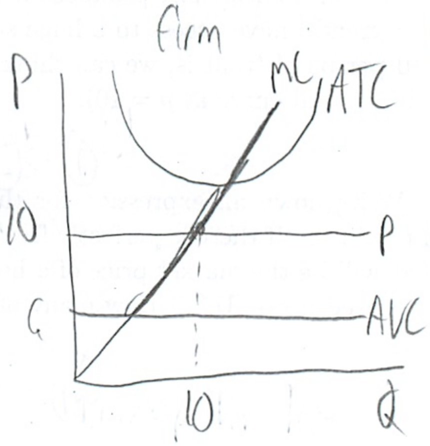
P = 10

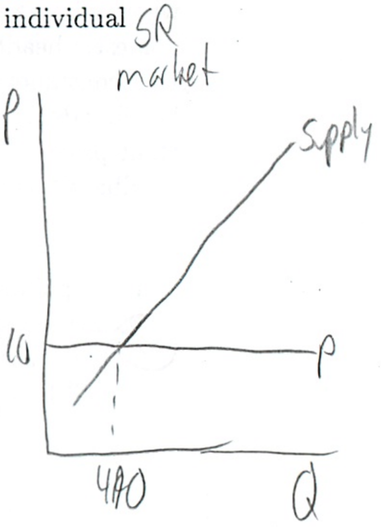
q = 12

π = 10·12 − 144

120 − 144

−24





10 = q

490 total

(c) (2 points) What do you predict would happen to the U.S. domestic headband industry in the long run?

All firms will go out of business in long run - the price is below their best ATC

(d) (3 points) Suppose the U.S. government passes a dramatic new trade bill, the Sweat-Trapping Headbands Industry Protection Act of 2009, outlawing all imports of foreign-made head- bands. If the number of domestic headband producers remains fixed at 49, what will be the new market price of a headband? How many headbands will be purchased in the U.S.?

-2

It would be back to normal. Each firm would want to produce 12 headbands for a total Q of 588 headbands. With the given demand curve the price would be an ~~outrageas 722~~ and ~~the amount demanded would~~ $12

Can't be right

$Q_D = 588$

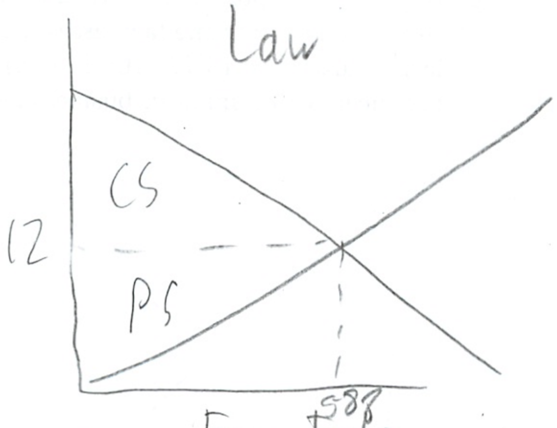
-? shortage

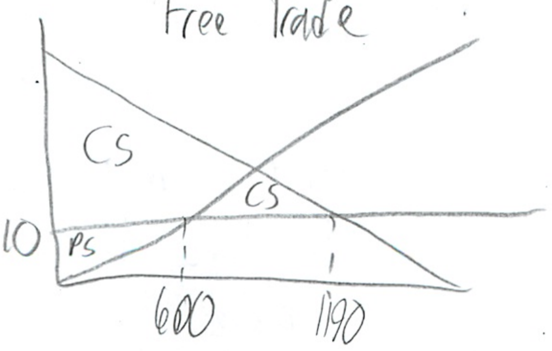
(e) (6 points) What will be the profits of each domestic producer after the new law is passed? What is the total increase in profits in the domestic headband industry as a result of this new trade law? Depict graphically the change in consumer surplus for headband buyers in the United States as a result of this policy as compared to your answers in (a). Under which scenario will consumer surplus be larger?

-6

~~The profits would be 0~~

$\pi = 12 \cdot 12 - 144$
$= 0$





CS larger under Free trade

what leads what?

law from part d

(f) (6 points) Assuming that the law described in (b) remains in force, but that there is free entry and exit in the domestic headband industry over time, what do you predict will be the long-run market equilibrium price? How many sweat-trapping headbands will be sold in the U.S.? How many headband-producing firms will there be in the U.S. in the long run?

$Q_s = 12 \cdot n = 1200 - p$

we know profit will be 0

$\pi = 12 \cdot p \Rightarrow 144 = 0$

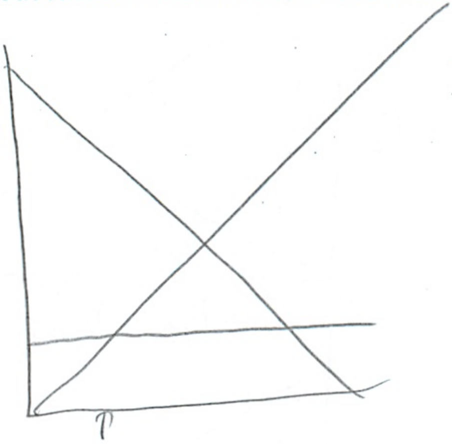
$p = 12$

$1200 - p = 1200 - 12 = 1188$

$1188 = 12n$

$n = \frac{1188}{12} = 99$ firms

(g) (8 points) Suppose that instead of the bill described in (b), the U.S. government decides to pass a less extreme law, assessing a $t\%$ tax on all imports of foreign headbands. How large must t be (5%? 10%? etc.) in order to ensure that the 49 existing domestic producers can remain in business in the long run?



Imports must be 712

Must have $2 tax -or

$\frac{2}{10} = 20\%$ tax

49 firms must make 12 items to stay in business

$12 \cdot 49 = 588$

END OF EXAM

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14.01 Exam 3 Fall 2009

Question 1: True/False/Uncertain (16 points)

In this section, write whether each statement is True, False or Uncertaint. You should fully explain your answer, including diagrams where appropriate. Points will be given based on your explanation.

(a) (4 points) Decreases in interest rates should lead to increases in higher education attendance (all else equal).

(b) (4 points) In insurance markets, risk based pricing is an example of third degree price discrimination.

(c) (4 points) There is always a first mover advantage in sequential games.

(d) (4 pionts) Increasing income taxes will lead to a decrease in labor hours supplied as employees receives less money (after taxes) for each hour they are at work.

Question 2 (10 points)

		Player 2	
		H	L
Player 1	H	(x, 4)	(3, 10)
	L	(2, 6)	(x, 20)

(a) (5 points) For what values of x does Player 1 have a dominant strategy? Which strategy for Player 1 is the dominant strategy?

(b) (5 points) Under what conditions on x is (L,L) a Nash equilibrium? What about (H,H)?

Question 3 (14 points)

Assume that a pharmaceutical monopolist has already developed a new drug that has a marginal cost of 0. It faces the following demand curve:

$$Q = 1000 - 2P$$

(a) (4 points) Determine the quantity, price, and profits of the monopolist.

(b) (4 points) The government decides to buy the rights to produce the drug from the monopolist, and maximize social welfare. What does the government need to offer the monopolist to buy these rights? What price will the government set for the drug?

(c) (6 points) Assume that the monopolist has two separate plants, where $MC_1(q) = 100$ and $MC_2(q) = q^2$. Determine the total quantity produced by the monopolist, as well as how the production of that quantity is split between the two plants.

Question 4 (10 points)

Lyndon has a utility function $U(S, N) = S \cdot N^2$, where S is his consumption of "stuff", and N is leisure. Lyndon divides all his time each day (24 hours) between working in a lab (L) and leisure (N). His job in the lab pays \$12 per hour and the price of "stuff" is \$1 per unit. In each of the cases below, Lyndon is free to choose the number of hours he works each day and he maximizes his utility.

(a) (3 points) How many hours does Lyndon choose to work each day at his current wage? What is his income?

(b) (3 points) Lyndon gets fired, but immediately finds another job in the student cafeteria that pays \$8 per hour. How many hours does he work now? What is his income?

(c) (4 points) MIT decides that every student employee should have a minimum income of \$100 per day. If Lyndon earns less than \$100 per day, the financial aid office gives him the difference. How many hours does Lyndon work now at his new job in the cafeteria from (b)? What is his income? Illustrate your answer using a diagram including his budget constraint, appropriate indifference curves and the number of hours of leisure. Put leisure on the x-axis. Your diagram does not need to be drawn to scale.

Question 5 (10 points)

As a manager at PDV Projects you can choose among the following investment projects:

Project 1 requires an investment of \$10,000 in 2010 and pays out \$11,000 in 2014.

Project 2 requires an investment of \$8,000 in 2010 and pays out \$1000 in 2011, \$2000 in 2012, and \$4000 in 2013 and \$5,000 in 2014.

Project 3 requires an investment of \$8,000 in 2010 and pays out \$3,000 in each of the years 2011 to 2014.

The interest rates for borrowing for each of the three projects are different (the bank can track your investments and monitor how you use the loan). The interest rates for each project are:

Project 1: 15%
Project 2: 15%
Project 3: 12%

All investments and payouts occur at the start of each year.

(a) (5 points) Write the formulas for computing the net present value of all three projects. No need to actually calculate the value.

(b) (5 points) Without making any calculations, which project has the highest net present value? Why?

Question 6 (20 points)

Suppose there are two consumers for good X: H and L. Define their respective demands by:

$$Q_H = 5 - P$$

and

$$Q_L = 3 - P$$

The producer of good X has monopoly power and his marginal cost is given by $c = 1$.

(a) (6 points) Suppose the producer cannot distinguish between consumer H and L and sets the same price for the two. What is the optimal price set by the producer of good X, the quantity sold at that price and the producer's profit? (Hint: both consumers will demand a positive amount at the optimum).

(b) (6 points) Suppose that the producer uses a two part tarriff with an entry fee M and a unit fee p. What are the profit-maximizing values of (M, p)? Give an intuition.

(c) (4 points) Is the producer better off under the pricing rule from (a) or (b)? What about the consumers in each group? Given your answer, relate it to a real life example of two part tariff pricing.

(d) (4 points) Would the producer be better off if he could discriminate between the two types of consumers? Why? Which type of discrimination would he start? Explain. (No math needed).

Question 7 (20 points)

The market for widgets is a Cournot duopoly. The market demand for widgets is given by:

$$Q = 120 - 2P$$

where Q is total output ($Q = Q_1 + Q_2$, the sum of firm 1's output, Q_1, and firm 2's output, Q_2). Each firm has a constant marginal cost of 0 of producing widgets.

(a) (4 points) Suppose that the two firms choose output cooperatively in order to maximize joint profits. What is the resulting total output and price for widgets? What are the resulting profits for each firm, if they choose the same output?

(b) (4 points) Suppose that firm 1 decides to defect from the cooperative agreement you found in part (a). What quantity Q_1 would firm 1 choose to produce if firm 2 continues to produce the agreed output from part (a)? What are the resulting profits for firm 1 and firm 2? Given these results is the cooperative agreement in part (a) sustainable?

(c) (6 points) What are the Cournot Equilibrium (simultaneous move game) output levels Q_1 and Q_2 for each firm, and the resulting market price P and firm profits?

(d) (6 points) Suppose now that firm 1 can choose its output level Q_1 before firm 2 chooses Q_2. What are the equilibrium output levels Q_1 and Q_2 for each firm and the rsulting market price P and firm profits?

14.01 Fall 2009: Exam 3 Solutions

December 14, 2009

Question 1: True/False/Uncertain (16 points)

In this section, write whether each statement is True, False or Uncertaint. You should fully explain your answer, including diagrams where appropriate. Points will be given based on your explanation.

(a) (4 points) Decreases in interest rates should lead to increases in higher education attendance (all else equal).

True. Higher education is an investment of tuition and foregone wages that pays dividends in the form of higher wages in the future. Decreases in interest rates will increase the NPV of this stream (assuming everything else remains the same), which should lead to more individuals making the investment/acquiring higher education.

(b) (4 points) In insurance markets, risk based pricing is an example of third degree price discrimination.

True. Risk based pricing is charging different prices to different individuals based on differences in their risk types (ie: smoking versus non-smoking). Third degree price discrimination is charging different prices to individuals with different demand curves (ie: smoker s have a different demand curve for health care than non-smokers).

(c) (4 points) There is always a first mover advantage in sequential games.

False. Example: Sequential quantity setting game (first mover advantage) vs. sequential price setting game (no first mover advantage).

(d) (4 pionts) Increasing income taxes will lead to a decrease in labor hours supplied as employees receives less money (after taxes) for each hour they are at work.

False. If the income effect dominates the substitution effect, decreases in net wages may lead to an increase in hours worked. This would be the outcome if the labor supply curve is "backward bending" .

Question 2 (10 points)

		Player 2	
		H	L
Player 1	H	(x, 4)	(8, 10)
	L	(2, 6)	(x, 20)

(a) (5 points) For what values of x does Player 1 have a dominant strategy? Which strategy for Player 1 is the dominant strategy?

For H to be a dominant strategy, x must be less than 8, and x must be greater than 2. L cannot be a dominant strategy, because this would imply x must be greater than 8, and at the same time x must be less than 2, which is impossible.

(b) (5 points) Under what conditions on x is (L,L) a Nash equilibrium? What about (H, H)?

Notice that Player 2 has a dominant strategy of L. So he will always play L and so (H, H) cannot be a Nash equilibrium. If x is less than 8, then the Nash equilibrium is (H,L). If x is greater than 8, then the Nash equilibrium is (L,L).

Question 3 (14 points)

Assume that a pharmaceutical monopolist has already developed a new drug that has a marginal cost of 0. It faces the following demand curve:

$$Q = 1000 - 2P$$

(a) (4 points) Determine the quantity, price, and profits of the monopolist.

The inverse demand function is $P = 500 - \frac{1}{2}Q$ which implies $MR = 500 - Q$. Profit maximization implies $MR = MC$ implies $Q = 500$ $P = 250$ and profits = 125000.

(b) (4 points) The government decides to buy the rights to produce the drug from the monopolist, and maximize social welfare. What does the government need to offer the monopolist to buy these rights? What price will the government set for the drug?

The government needs to offer the monopolist profit, or 125000. It will sell the drugs for free, because that is the price at which social welfare, which in this case is only consumer surplus is maximized.

(c) (6 points) Assume that the monopolist has two separate plants, where $MC_1(q) = 100$ and $MC_2(q) = q^2$. Determine the total quantity produced by the monopolist, as well as how the production of that quantity is split between the two plants.

At the optimum, $MC_1 = MC_2$, which implies that $Q_2 = 10$. This condition must hold because if the marginal cost between the two plants are different, then you can reallocate production and decrease costs without changing quantity. The rest of the quantity will *be produced at plant 1. The monopolist sets $MR = MC_1 = MC_2$ so this implies total quantity produced is 400. Thus, 390 units are produced at plant one, and 10 units are produced at plant 2.*

Question 4 (10 points)

Lyndon has a utility function $U(S, N) = S \cdot N^2$, where S is his consumption of "stuff", and N is leisure. Lyndon divides all his time each day (24 hours) between working in a lab (L) and leisure (N). His job in the lab pays $12 per hour and the price of "stuff" is $1 per unit. In each of the cases below, Lyndon is free to choose the number of hours he works each day and he maximizes his utility.

(a) (3 points) How many hours does Lyndon choose to work each day at his current wage? What is his income?

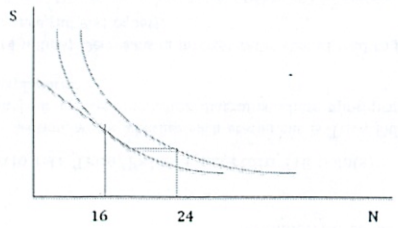
$\max\{S \cdot N^2\}$ s.t. $S + 12N \leq 24 \cdot 12$. $N = 16$, $L = 8$ and $Income = \$96$ *(interior solution since corner solution implies $U = 0$).*

(b) (3 points) Lyndon gets fired, but immediately finds another job in the student cafeteria that pays $8 per hour. How many hours does he work now? What is his income?

$\max\{S \cdot N^2\}$ s.t. $S + 8N \leq 24 \cdot 8$. $N = 16$, $L = 8$ and $Income = \$64$ *(interior solution since corner solution implies $U = 0$).*

(c) (4 points) MIT decides that every student employee should have a minimum income of $100 per day. If Lyndon earns less than $100 per day, the financial aid office gives him the difference. How many hours does Lyndon work now at his new job in the cafeteria from (b)? What is his income? Illustrate your answer using a diagram including his budget constraint, appropriate indifference curves and the number of hours of leisure. Put leisure on the x-axis. Your diagram does not need to be drawn to scale.

$\max\{S \cdot N^2\}$ s.t. $S + 8N \leq 24 \cdot 8 + 100$. *Interior solution: $N = 24\frac{1}{3} > 24$, hence corner solutions with $N = 24$and $L = 0$. and $Income = \$100$ and Lyndon does not work now.*



Question 5 (10 points)

As a manager at PDV Projects you can choose among the following investment projects:

Project 1 requires an investment of $10,000 in 2010 and pays out $11,000 in 2014.

Project 2 requires an investment of $8,000 in 2010 and pays out $1000 in 2011, $2000 in 2012, and $4000 in 2013 and $5,000 in 2014.

Project 3 requires an investment of $8,000 in 2010 and pays out $3,000 in each of the years 2011 to 2014.

The interest rates for borrowing for each of the three projects are different (the bank can track your investments and monitor how you use the loan). The interest rates for each project are:

Project 1: 15%
Project 2: 15%
Project 3: 12%
All investments and payouts occur at the start of each year.

(a) (5 points) Write the formulas for computing the net present value of all three projects. No need to actually calculate the value.

NPV of Project 1: $-10000 + \frac{11000}{(1+.15)^4}$

NPV of Project 2: $-8000 + \frac{1000}{(1+.15)} + \frac{2000}{(1+.15)^2} + \frac{4000}{(1+.15)^3} + \frac{5000}{(1+.15)^4}$

NPV of Project 3: $-8000 + \frac{3000}{(1+.12)} + \frac{3000}{(1+.12)^2} + \frac{3000}{(1+.12)^3} + \frac{3000}{(1+.12)^4}$

(b) (5 points) Without making any calculations, which project has the highest net present value? Why?

Project 1 is dominated by projects 2 and 3. Projects 2 and 3 have the same nominal payoffs, but Project 2 has more backloaded payments and a higher discount rate—so Project 2 has the highest NPV.

Question 6 (20 points)

Suppose there are two consumers for good X: H and L. Define their respective demands by:

$$Q_H = 5 - P$$

and

$$Q_L = 3 - P$$

The producer of good X has monopoly power and his marginal cost is given by $c = 1$.

(a) (6 points) Suppose the producer cannot distinguish between consumer H and L and sets the same price for the two. What is the optimal price set by the producer of good X, the quantity sold at that price and the producer's profit? (Hint: both consumers will demand a positive amount at the optimum).

The aggregate demand is given by

$$Q_A = \begin{cases} 5 - P & if\ P > 3 \\ 8 - 2P & if\ P \leq 3 \end{cases}$$

$$or\ P(Q) = \begin{cases} 5 - Q & if\ Q < 2 \\ 4 - \frac{1}{2}Q & if\ Q > 2 \end{cases}$$

The optimization problem of the monopolist is set as

$$\max_Q\ P(Q)\,Q - cQ$$

where $P(Q) = 4 - \frac{Q}{2}$ *(given the hint). The solution of the problem is given by:*

$$\begin{aligned} MR &= MC \\ &\Leftrightarrow \\ 4 - Q &= 1 \end{aligned}$$

Hence, $Q^* = 3$ *and* $P^* = \frac{5}{2}$. $\pi = \frac{3}{2} \cdot 3 = \frac{9}{2}$.

(b) (6 points) Suppose that the producer uses a two part tarriff with an entry fee M and a unit fee p. What are the profit-maximizing values of (M, p)? Give an intuition.

The surplus of each consumer is given by:

$$\begin{aligned} S_H &= \frac{(5-p)^2}{2} \\ S_L &= \frac{(3-p)^2}{2} \end{aligned}$$

a. Let $P = 1$ *and set* $M_H = 8$. *In which case, the profit of the owner is given by* $\pi = 8$

b. Let $M_L(p) = \frac{(3-p)^2}{2}$, *i.e. the surplus of the consumer with the lower demand. In which case, his profit is given by:*

$$\pi(p) = (3-p)^2 + (p-1)(8-2p)$$

c. Maximizing π *with respect to p, one can find the* M_L *and p.*

Hence, $P^* = 2$ *and* $M_L = \frac{1}{2}$. *This gives a profit of* $\pi_L = 1 + 4 = 5$

d. Compare the profits of the owner in the two cases.

The optimal (M, L) *will be* $(8, 1)$ *because* $\pi_H > \pi_L$.

As we can notice the owner prefers to set a higher entry cost as it will allow to get a higher profit. The loss of the second group is not that costly given their low demand. The gain from having them enter the market and having a higher price does not make it for the loss in term of a lower entry cost.

(c) (4 points) Is the producer better off under the pricing rule from (a) or (b)? What about the consumers in each group? Given your answer, relate it to a real life example of two part tariff pricing.

The profit of the owner is given by 8 and is higher than the monopoly profit $\frac{9}{2}$. *Squash court facilities in a gym often require the consumers to pay a fixed fee. Once they paid the fixed fee, then can access the squash court paying a lower amount. Setting a two part tarriff can make sense as it can increase the profit of the owner of the squash facility.*

(d) (4 points) Would the producer be better off if he could discriminate between the two types of consumers? Why? Which type of discrimination would he start? Explain. (No math needed).

Yes the owner would be better off as he could extract the surplus of both consumers more effectively.

Question 7 (20 points)

The market for widgets is a Cournot duopoly. The market demand for widgets is given by:

$$Q = 120 - 2P$$

where Q is total output ($Q = Q_1 + Q_2$, the sum of firm 1's output, Q_1, and firm 2's output, Q_2). Each firm has a constant marginal cost of 0 of producing widgets.

(a) (4 points) Suppose that the two firms choose output cooperatively in order to maximize joint profits. What is the resulting total output and price for widgets? What are the resulting profits for each firm, if they choose the same output?

When the two firms act cooperatively they operate like a single monopolist in the market. The monopolist profit is given by

$$\pi_M(Q) = (P(Q) - MC)Q = (60 - \frac{1}{2}Q - 0)Q$$

and so the profit maximizing output level solves: $\frac{d\pi_M}{dQ} = 60 - Q = 0$ *and so* $Q = 60$. *Hence,*$P = 30$ *and* $Q_1 = Q_2 = 30$. *Each firm gets a profit of* $\pi_1 = \pi_2 = 30 \cdot 30 = 900$.

(b) (4 points) Suppose that firm 1 decides to defect from the cooperative agreement you found in part (a). What quantity Q_1 would firm 1 choose to produce if firm 2 continues to produce the agreed output from part (a)? What are the resulting profits for firm 1 and firm 2? Given these results is the cooperative agreement in part (a) sustainable?

Suppose that $Q_2 = 30$. *Then firm 1's profit function is* $\pi_1(Q_1, 30) = (60 - \frac{1}{2}(30 + Q_1) - 0)Q_1$ *and so the profit mizimizing output level for firm 1 solves:* $\frac{d\pi_1}{dQ_1} = 45 - Q_1 = 0$ *and so* $Q_1 = 45$. *Hence,* $P = 60 - \frac{1}{2}75 = 22.5$ *and so* $\pi_1 = 22.5 \cdot 45 = 1012.5$ *and* $\pi_2 = 22.5 \cdot 30 = 675$. *Since,* $1012.5 > 900$ *the cooperative agreement from part (a) is not sustainable.*

(c) (6 points) What are the Cournot Equilibrium (simultaneous move game) output levels Q_1 and Q_2 for each firm, and the resulting market price P and firm profits?

Firm 1's profit function is given by $\pi_1(Q_1, Q_2) = (60 - \frac{1}{2}(Q_1 + Q_2))Q_1$. *Hence, firm 1's reaction function is given by:*

$$\frac{d\pi_1}{dQ_1} = 60 - \frac{1}{2}Q_2 - Q_1 = 0$$

or

$$Q_1(Q_2) = 60 - \frac{1}{2}Q_2$$

Since the two firms are symmetric we have that $Q_2(Q_1) = 60 - \frac{1}{2}Q_1$. *Hence, the Cournot equilibrium output levels are* $Q_1^E = Q_2^E$ *such that* $Q_1^E = Q_1(Q_2^E)$ *and so* $Q_1^E = 40 = Q_2^E$. *Hence,* $P = 20$ *and* $\pi_1 = \pi_2 = 20 \cdot 40 = 800$.

(d) (6 points) Suppose now that firm 1 can choose its output level Q_1 before firm 2 chooses Q_2. What are the equilibrium output levels Q_1 and Q_2 for each firm and the rsulting market price P and firm profits?

We have that $Q_2(Q_1) = 60 - \frac{1}{2}Q_1$. *Hence, firm 1's profit is* $\pi_1(Q_1) = (60 - \frac{1}{2}(Q_1 + 60 - \frac{1}{2}Q_1))Q_1 = (30 - \frac{1}{4}Q_1)Q_1$. *Hence,* Q_1^* *solves:* $\frac{d\pi_M}{dQ_1} = 30 - \frac{1}{2}Q_1 = 0$. *Hence,* $Q_1^* = 60$ *and* $Q_2^* = 30$ *and so* $P = 15$. $\pi_1 = 900$ *and* $\pi_2 = 450$.

1. (5 minutes) Which of the following two observations is an example of moral hazard?

   (A) Drivers who have car insurance tend to drive less carefully.

   (B) Drivers who are at higher risk of an accident are more likely to buy car insurance.

2. (5 minutes) In the payoff matrix below, Roger has three strategies $\{U, M, D\}$, while Jesse has two strategies $\{L, R\}$. The first number in each cell is Roger's payoff, while the second number is Jesse's payoff.

	Jesse plays *L*	**Jesse plays *R***
Roger plays *U*	(4, 5)	(2, 4)
Roger plays *M*	(3, 2)	(3, 1)
Roger plays *D*	(2, 4)	(1, 5)

What is the Nash equilibrium of this game? (*Hint*: What strategy will Roger never play?)

3. (5 minutes) Tal can choose between two assets:

Asset #1 has zero income during time periods $t = 0$ and $t = 1$. Beginning in time period $t = 2$ and continuing forever, Asset #1 has constant income y_1 per time period.

Asset #2 has zero income during time period $t = 0$. Beginning in time period $t = 1$ and continuing forever, Asset #2 has constant income y_2 per time period, where $y_2 < y_1$.

At what interest rate r will Tal be indifferent between Asset #1 and Asset #2? (Your answer will be a formula that depends on y_1 and y_2.)

4. (5 minutes) There are two types of consumers of server computers:

> Type-A consumers have a *high* willingness to pay for hard drive capacity, and also have a *high* willingness to pay for memory.
>
> Type-B consumers have a *low* willingness to pay for hard drive capacity, and also have a *low* willingness to pay for memory.

Explain whether the following statement is *True* or *False*: "A monopoly producer of server computers will make higher profit by bundling hard drive capacity and memory."

5. (5 minutes) Chia-Hui's Factory produces steel according to the total cost function $TC(y) = 2y^2$, where y is the output. Unfortunately, steel production causes air pollution, which results in a total external cost $EC(y) = y^2$. The market demand for steel is perfectly elastic at the price $p = 12$. What is the socially optimal output of steel? If the government wanted to induce Chia-Hui's Factory to produce the socially optimal quantity of steel, what tax t should it impose on each unit of steel produced?

6. (5 minutes) Nirupama works for Big Bank. Nirupama chooses between consumption C and leisure R. There are a total of 24 hours in a day, so that Nirupama's supply of labor is $L = 24 - R$. Nirupama's wage rate is w dollars per hour, and the price of consumption is 1. Nirupama's utility function is $U(C,R) = CR$. Derive Nirupama's supply of labor.

7. (10 minutes) A monopoly faces a market demand $Q = 60 - P$ and has a cost function $C(Q) = Q^2$. Calculate the following quantities: the profit-maximizing price; the profit-maximizing quantity; and the deadweight loss due to monopoly pricing.

8. (20 minutes) All the individuals in a large city have an independent risk of having a very serious illness that will cause them to lose all their wealth. There are two types of individuals: high risk (*H*) and low risk (*L*). High-risk individuals have a probability $p_H = \frac{2}{3}$ of having the disease, while low-risk individuals have a probability $p_L = \frac{1}{3}$ of having the disease. Each individual knows his own risk type. All individuals have initial wealth $W_0 > 0$ and utility function $U(W) = \sqrt{W}$. An insurance company cannot determine who is high-risk or low-risk. It offers full coverage against the loss of wealth in the event of illness, and sets the insurance premium to break even. The proportion of low-risk individuals in the population is equal to α, where $1 \geq \alpha \geq 0$. Determine the range of values of α for which low-risk individuals will choose to buy the insurance coverage.

9. (20 minutes) A monopoly tennis club may charge an initiation fee F per member, as well as a price p per hour of court time. The club has no fixed costs and the marginal cost of court time is zero. There are two types of potential members: 100 upper-class (U) individuals and 100 middle-class (M) individuals. Each upper-class individual has a demand function $q_U = 4 - p$, where q_U is the number of hours of court time. Each middle-class individual has an analogous demand function $q_M = 2 - p$. The club must charge the same initiation fee and the same price per court time for all members. What are the profit-maximizing values of F and p?

10. (20 minutes) Two firms, named Leader and Follower, are the only producers of fish oil, which is a homogeneous product. The firms play a two-stage, sequential game. In the first stage, Leader chooses the level of advertising A for fish oil, while Follower does not advertise. The cost to Leader of advertising at level A is equal to $A^3/24$. In the second stage, Leader and Follower engage in Stackelberg competition, in which Leader chooses the quantity y_L of fish oil that it will produce, and then Follower chooses the quantity y_F of fish oil that it will produce. In the second stage, the market demand curve is $p = A - y$, where p is the price of fish oil, and where $y = y_L + y_F$ is the total output of fish oil. Both firms have zero marginal cost of production of fish oil and, aside from the costs of advertising, there are no fixed costs.

a. Assume that Leader chooses level of advertising A in the first stage. Determine the outputs y_L and y_F in the second stage as a function of A. Determine the profit of Leader in the second stage, exclusive of advertising costs.

b. Determine the profit-maximizing level of advertising chosen by Leader in the first stage.

11. (20 minutes) Brandon's Farm employs unskilled laborers to produce food. The Farm is the only employer of unskilled laborers in the province. The Farm's production function is $Q = 6\sqrt{L}$, where Q is the quantity of food and L is the labor input, which is measured in hours. Brandon's Farm sells food at a price $p = 1$ in a competitive product market. The supply of unskilled labor in the province is given by $L_S(w) = 4w^2$, where w denotes the hourly wage rate.

a. Suppose that Brandon's Farm is a price-taker in the labor market. Determine the Farm's demand for labor $L_D(w)$ as a function of w. What will be the equilibrium wage rate w^* for unskilled labor? What will be the equilibrium quantity L^* of unskilled labor? (Hint: For your information $\sqrt{1.5} \simeq 1.225$.)

b. Suppose instead Brandon's Farm is a *monopsonist* in the unskilled labor market. Determine the quantity of labor L_M employed by the Farm, as well as the wage w_M that the Farm will pay.

c. The government now imposes a minimum wage $w_{\min} = 1.1$. Determine the quantity of labor L that Brandon's Farm will employ.

Massachusetts Institute of Technology
Department of Economics
14.01 Principles of Microeconomics
Midterm Exam #3 Answers
Tuesday May 19, 2009

Last Name (Please print): ______________________________
First Name: ______________________________
MIT Email Address: ______________________________
MIT ID Number: ______________________________

Instructions. Please read carefully.

This is a 120-minute closed book exam. No notes, calculators, books, or other aids are permitted. Concisely answer all questions in the space provided, below each question. Do not attach additional sheets of paper. Write your name and MIT ID number at the top of each of the 15 pages. If you think that a question is ambiguous, you should explain in your written answer what you found unclear and how you resolved the ambiguity.

Please check the recitation or section that you are attending.

☐	Lecture + F10 (12-122)	Chia-Hui Chen	☐	MWF9 (4-159)	Jesse Edgerton
☐	Lecture + F11 (12-122)	Chia-Hui Chen	☐	MWF10 (4-159)	Jesse Edgerton
☐	Lecture + F12 (12-122)	Nirupama Rao	☐	MWF11 (12-142)	Tal Gross
☐	Lecture + F1 (12-122)	Nirupama Rao	☐	MWF11 (12-142)	Eric Weese
☐	Lecture + F1 (1-190)	Eric Weese/ Chia-Hui Chen	☐	MWF12 (12-142)	Eric Weese
☐	Lecture + F2 (12-122)	Nirupama Rao	☐	MWF2 (4-163)	Brandon Lehr

Do not write below this line.

#1		5	**#4**		5	**#7**		10	**#10**		20
#2		5	**#5**		5	**#8**		20	**#11**		20
#3		5	**#6**		5	**#9**		20	**Total**		120

Name ______________________ MIT ID ______________________

1. (5 minutes) Which of the following two observations is an example of moral hazard?

   (A) Drivers who have car insurance tend to drive less carefully.

   (B) Drivers who are at higher risk of an accident are more likely to buy car insurance.

Answer: A.

(While you were not required to say so, observation B is an example of *adverse selection.*)

2. (5 minutes) In the payoff matrix below, Roger has three strategies $\{U, M, D\}$, while Jesse has two strategies $\{L, R\}$. The first number in each cell is Roger's payoff, while the second number is Jesse's payoff.

	Jesse plays *L*	**Jesse plays *R***
Roger plays *U*	(4, 5)	(2, 4)
Roger plays *M*	(3, 2)	(3, 1)
Roger plays *D*	(2, 4)	(1, 5)

What is the Nash equilibrium of this game? (*Hint:* What strategy will Roger never play?)

Answer: The Nash equilibrium is (U, L) in the upper left corner. To see why, note first that Roger will never play *D*, as he can always do better playing *U* or *M*. Given that Roger will never play *D*, Jesse will always be better off playing *L*. Given that Jesse plays *L*, Roger will play *U*.

3. (5 minutes) Tal can choose between two assets:

> Asset #1 has zero income during time periods $t = 0$ and $t = 1$. Beginning in time period $t = 2$ and continuing forever, Asset #1 has constant income y_1 per time period.
>
> Asset #2 has zero income during time period $t = 0$. Beginning in time period $t = 1$ and continuing forever, Asset #2 has constant income y_2 per time period, where $y_2 < y_1$.

At what interest rate r will Tal be indifferent between Asset #1 and Asset #2? (Your answer will be a formula that depends on y_1 and y_2.)

Answer: The present discounted value of Asset #1 is $PDV_1 = \frac{y_1}{(1+r)r}$, whereas the present discounted value of Asset #2 is $PDV_2 = \frac{y_2}{r}$. Tal will be indifferent when $PDV_1 = PDV_2$, that is, when $r = \frac{y_1}{y_2} - 1$.

4. (5 minutes) There are two types of consumers of server computers:

Type-A consumers have a *high* willingness to pay for hard drive capacity, and also have a *high* willingness to pay for memory.

Type-B consumers have a *low* willingness to pay for hard drive capacity, and also have a *low* willingness to pay for memory.

Explain whether the following statement is *True* or *False*: "A monopoly producer of server computers will make higher profit by bundling hard drive capacity and memory."

Answer: *False*. If demands for the two goods are positively correlated, then a firm with market power will not make higher profit by bundling.

5. (5 minutes) Chia-Hui's Factory produces steel according to the total cost function $TC(y) = 2y^2$, where y is the output. Unfortunately, steel production causes air pollution, which results in a total external cost $EC(y) = y^2$. The market demand for steel is perfectly elastic at the price $p = 12$. What is the socially optimal output of steel? If the government wanted to induce Chia-Hui's Factory to produce the socially optimal quantity of steel, what tax t should it impose on each unit of steel produced?

Answer: The total social cost is the sum of the private and external costs, or $SC(y) = TC(y) + EC(y) = 3y^2$. Therefore, the social marginal cost is $SMC(y) = 6y$. To get the socially optimal quantity of steel, we set price equal to social marginal cost, which gives $6y = 12$, or $y^* = 2$. At that output, the social marginal cost is $SMC(y^*) = 4$. Therefore, the tax required to induce Chia-Hui's factory to produce the socially optimal quantity of steel is $t = 4$. (You can check that if the tax were set at $t = 4$, then Chia-Hui's new marginal cost would be $4y + 4$. If she set marginal cost equal to price, then $4y + 4 = 12$, or $y = 2$.)

6. (5 minutes) Nirupama works for Big Bank. Nirupama chooses between consumption C and leisure R. There are a total of 24 hours in a day, so that Nirupama's supply of labor is $L = 24 - R$. Nirupama's wage rate is w dollars per hour, and the price of consumption is 1. Nirupama's utility function is $U(C,R) = CR$. Derive Nirupama's supply of labor.

Answer: The budget constraint is $C = wL$, or equivalently, $C = w(24 - R)$. Plugging this expression into the utility function gives $U = w(24 - R)R$. Setting $\frac{dU}{dR} = 0$ gives $R = 12$, and therefore the supply of labor is $L = 12$, which is independent of the wage w.

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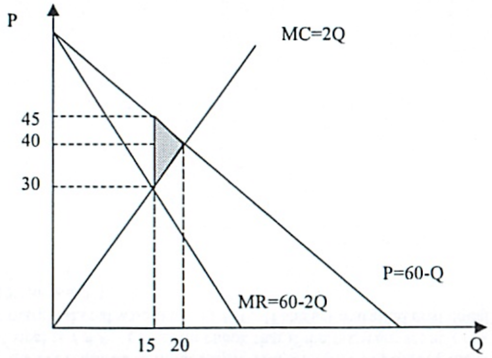
7. (10 minutes) A monopoly faces a market demand $Q = 60 - P$ and has a cost function $C(Q) = Q^2$. Calculate the following quantities: the profit-maximizing price; the profit-maximizing quantity; and the deadweight loss due to monopoly pricing.

Answer: The firm's revenue function is $R = PQ - (60 - Q)Q$. Therefore, marginal revenue is $MR = 60 - 2Q$. Marginal cost is $MC = 2Q$. To maximize profit, a monopoly will set $MR = MC$, or $60 - 2Q = 2Q$. So the profit-maximizing quantity is $Q^* = 15$. The profit-maximizing price is $P^* = 60 - Q^* = 45$. The marginal cost at the monopoly output is $2Q^* = 30$. At the socially optimum, $P = MC$, that is, $60 - Q = 2Q$, so the socially optimal quantity is $Q' = 20$. The deadweight loss (*DWL*) is the area of the shaded triangle in the graph. (You did not need to draw such a graph to get full credit.)

We compute: $DWL = \frac{1}{2}(45 - 30)(20 - 15) = 37.5$.



8. (20 minutes) All the individuals in a large city have an independent risk of having a very serious illness that will cause them to lose all their wealth. There are two types of individuals: high risk (*H*) and low risk (*L*). High-risk individuals have a probability $p_H = \frac{2}{3}$ of having the disease, while low-risk individuals have a probability $p_L = \frac{1}{3}$ of having the disease. Each individual knows his own risk type. All individuals have initial wealth $W_0 > 0$ and utility function $U(W) = \sqrt{W}$. An insurance company cannot determine who is high-risk or low-risk. It offers full coverage against the loss of wealth in the event of illness, and sets the insurance premium to break even. The proportion of low-risk individuals in the population is equal to α, where $1 \geq \alpha \geq 0$. Determine the range of values of α for which low-risk individuals will choose to buy the insurance coverage.

Answer: If low-risk individuals do buy the insurance coverage, then the average probability of having the disease will be $\bar{p} = \alpha p_L + (1-\alpha) p_H = \frac{2}{3} - \frac{\alpha}{3}$, and therefore the breakeven insurance premium will be $R = \left(\frac{2}{3} - \frac{\alpha}{3}\right) W_0$. A low-risk individual will have an expected utility without insurance equal to

$$E_L^{No\ Insurance}[U] = (1 - p_L)\sqrt{W_0} = \frac{2}{3}\sqrt{W_0}$$

while his expected utility with insurance will be

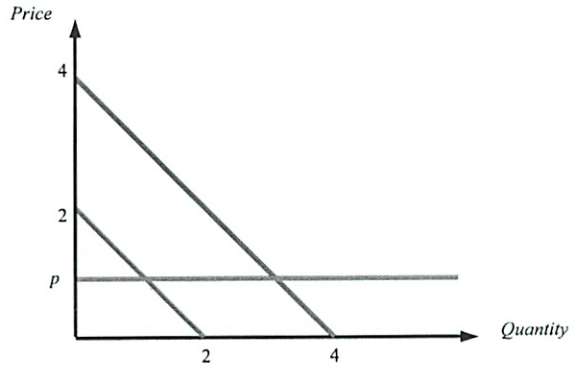
$$E_L^{Insurance}[U] = \sqrt{W_0 - R} = \sqrt{W_0 - \left(\frac{2}{3} - \frac{\alpha}{3}\right) W_0} = \sqrt{W_0\left(\frac{1}{3} + \frac{\alpha}{3}\right)}$$

A low-risk individual will choose to buy coverage if $E_L^{Insurance}[U] > E_L^{No\ Insurance}[U]$, which implies

$$\sqrt{\frac{1}{3} + \frac{\alpha}{3}} > \frac{2}{3} \quad \text{or} \quad \alpha > \frac{1}{3}.$$

9. (20 minutes) A monopoly tennis club may charge an initiation fee F per member, as well as a price p per hour of court time. The club has no fixed costs and the marginal cost of court time is zero. There are two types of potential members: 100 upper-class (U) individuals and 100 middle-class (M) individuals. Each upper-class individual has a demand function $q_U = 4 - p$, where q_U is the number of hours of court time. Each middle-class individual has an analogous demand function $q_M = 2 - p$. The club must charge the same initiation fee and the same price per court time for all members. What are the profit-maximizing values of F and p?

Answer: $F = 8$ and $p = 0$. There are two possibilities. The club can set the price $p = 0$ and then set the initiation fee equal to the consumer surplus of an upper-class individual, that is, $F = 8$. The lower-class individuals will not become members, and the total profit will then be $100F = 800$. Alternatively, the club can set $2 \geq p > 0$ and then set the initiation fee equal to the consumer surplus of a middle-class individual, that is, $F = \frac{1}{2}(2-p)^2$. This alternative is illustrated in the diagram below, where the price per hour of court time corresponds to the horizontal blue line, and where F is the area of the yellow shaded triangle. (It was not necessary to draw such a graph to obtain full credit.) The total profit will then be $100\left(2F + (q_U + q_M)p\right)$. The latter expression equals $100\left((2-p)^2 + (6-2p)p\right) = 100\left(4 + 2p - p^2\right)$. This expression is maximized at $p = 1$. But at that price, the total profit will be $100\left(4 + 2(1) - (1)^2\right) = 500$. Therefore, the first option will be selected, and the profit-maximizing values are $F = 8$ and $p = 0$.



10. (20 minutes) Two firms, named Leader and Follower, are the only producers of fish oil, which is a homogeneous product. The firms play a two-stage, sequential game. In the first stage, Leader chooses the level of advertising A for fish oil, while Follower does not advertise. The cost to Leader of advertising at level A is equal to $A^3/24$. In the second stage, Leader and Follower engage in Stackelberg competition, in which Leader chooses the quantity y_L of fish oil that it will produce, and then Follower chooses the quantity y_F of fish oil that it will produce. In the second stage, the market demand curve is $p = A - y$, where p is the price of fish oil, and where $y = y_L + y_F$ is the total output of fish oil. Both firms have zero marginal cost of production of fish oil and, aside from the costs of advertising, there are no fixed costs.

a. Assume that Leader chooses level of advertising A in the first stage. Determine the outputs y_L and y_F in the second stage as a function of A. Determine the profit of Leader in the second stage, exclusive of advertising costs.

Answer: The reaction function of Follower is $y_F = \frac{A - y_L}{2}$. Therefore, Leader chooses y_L to maximize $\pi_2 = (A - y_L - y_F)y_L = \left(A - y_L - \frac{A - y_L}{2}\right)y_L = \left(\frac{A - y_L}{2}\right)y_L$. This expression is maximized when $y_L = \frac{A}{2}$, which gives $\pi_2 = \frac{A^2}{8}$.

Part (b) of this problem is on the following page.

b. Determine the profit-maximizing level of advertising chosen by Leader in the first stage.

Answer: The overall profit in the first stage is $\pi_1 = \frac{A^2}{8} - \frac{A^3}{24}$, so $\frac{d\pi_1}{dA} = 0$ implies $A = 2$.

11. (20 minutes) Brandon's Farm employs unskilled laborers to produce food. The Farm is the only employer of unskilled laborers in the province. The Farm's production function is $Q = 6\sqrt{L}$, where Q is the quantity of food and L is the labor input, which is measured in hours. Brandon's Farm sells food at a price $p = 1$ in a competitive product market. The supply of unskilled labor in the province is given by $L_S(w) = 4w^2$, where w denotes the hourly wage rate.

a. Suppose that Brandon's Farm is a price-taker in the labor market. Determine the Farm's demand for labor $L_D(w)$ as a function of w. What will be the equilibrium wage rate w^* for unskilled labor? What will be the equilibrium quantity L^* of unskilled labor? (Hint: For your information $\sqrt{1.5} \approx 1.225$.)

Answer: Profit equals $\pi = pQ - wL = 6\sqrt{L} - wL$. Setting $\frac{d\pi}{dL} = 0$ gives: $L_D(w) = \frac{9}{w^2}$.

To get the equilibrium wage, we set $L_D(w) = L_S(w)$, which gives $\frac{9}{w^2} = 4w^2$, or $w^* = \sqrt{1.5} \approx 1.225$. The equilibrium quantity of unskilled labor is $L^* = 6$.

Part (b) of this problem is on the following page.

b. Suppose instead Brandon's Farm is a *monopsonist* in the unskilled labor market. Determine the quantity of labor L_M employed by the Farm, as well as the wage w_M that the Farm will pay.

Answer: Profit equals $\pi = pQ - wL = 6\sqrt{L} - wL$. Since $L_S(w) = 4w^2$, we can write $w = \frac{\sqrt{L}}{2}$. This implies $\pi = 6L^{1/2} - \frac{1}{2}L^{3/2}$. Setting $\frac{d\pi}{dL} = 0$ gives: $3L^{-1/2} - \frac{3}{4}L^{1/2} = 0$, or $L_M = 4$. The Farm will pay $w_M = \frac{\sqrt{L_M}}{2} = 1$.

Part (c) of this problem is on the following page.

c. The government now imposes a minimum wage $w_{\min} = 1.1$. Determine the quantity of labor L that Brandon's Farm will employ.

Answer: The minimum wage does not exceed the equilibrium wage w^*. Therefore, the firm will employ $L_S(w_{\min}) = 4(1.1)^2 = 4.84$.

END OF EXAM

Question 1 (Chapter 10, 20 points)

Consider a monopolist with a cost function $C(q) = 8q + q^2$, facing market demand $q = 20 - p$.

a. (5 points) Find the monopoly's profit-maximizing choice of quantity and price.

b. (7 points) Calculate the deadweight loss of the monopoly.

c. (8 points) Suppose that the government wanted the monopolist to produce the competitive equilibrium output. Would the government have to tax or subsidize the production of the monopoly? What level of per-unit tax or per-unit subsidy would the government have to impose on the monopoly? Assuming that the government imposed such a tax or subsidy, calculate the resulting deadweight loss.

Question 2 (Chapter 11, 20 points)

a. (6 points) There are two types of golfers in a town. There are serious golfers who like to golf often. Each serious golfer has demand given by: $Q_1 = 100 - P$, where Q_1 is the number of rounds of golf per year and P is the fee for each round of golf. There are also recreational golfers, each of whom has a demand given by: $Q_2 = 40 - \frac{1}{2}P$. Assume there are 80 serious players and 10 recreational players in this town. The fixed cost of running the golf club is \$10,000 per year and the marginal cost of providing a round of golf to a customer is \$20. Assume that the golf club can distinguish serious and recreational players from each other and that the golf club can charge only for each round of golf. What prices should the golf club charge each type of player in order to maximize its total annual profit? How many rounds of golf will each type of golfer play per year?

b. (14 points) Now assume that the golf club cannot distinguish between serious and recreational players. However, the club can charge the same membership fee and the same price per round of golf to any player. What is the profit-maximizing membership fee? What is the profit-maximizing fee per round of golf? How many golfers of each type will play?

Question 3 (Chapter 12, 12 points)

a. (8 points) Consider two firms both selling soap. Their products are differentiated and they compete by choosing prices simultaneously. In particular, the demand functions for each firm are:

$$\begin{aligned} Q_1 &= 12 - 2P_1 + P_2 \\ Q_2 &= 12 - 2P_2 + P_1 \end{aligned}$$

Let marginal costs equal 0 for both firms. Both firms have no fixed costs. Determine the price that each firm will charge in a Nash equilibrium.

b. (4 points) Suppose that firm 1 sets the price of its soap first, and then firm 2 sets the price of its product second. After the two firms set their prices, there can be no further price changes. Determine the new equilibrium price for each firm. Explain whether the following statement is True or False: In comparison to the simultaneous-move game in part (a), firm 1 attains a greater increase in profit than firm 2 because firm 1 can now move first.

Question 4 (Chapter 13, 8 points)
Consider the following two player game where the first number in each box is Player 1's payoff and the second number is Player 2's payoff:

		Player 2	
		Left	Right
Player 1	Top	2 , 5	3 , 5
	Bottom	4 , a	b , 0

a. (2 points) For what value of b does Player 1 have a dominant strategy?

b. (3 points) Using the condition you found in part (a), what additional conditions on a will give a unique Nash Equilibrium in the above game?

c. (3 points) Find conditions on the constants a and b in the above game such that there are three (pure strategy) Nash Equilibria.

Question 5 (Chapter 14, 10 points)

a. (6 points) A firm uses a single input, labor L, in a competitive labor market to produce output q according to the production function

$$q = 4\sqrt{L} + \frac{1}{3}L$$

The output sells on a competitive market at a price of \$40 per unit and the wage is \$20 an hour. Find the profit maximizing quantity of L and q.

b. (4 points) Assume that everything in the above setup is unchanged, except that now the firm is a monopolist in the output market. Explain how this will affect the firm's demand for labor in the input market.

Question 6 (Chapter 15, 7 points)

a. (4 points) Consider two perpetuities (bonds that pay out a fixed amount of money each year, forever). Perpetuity A costs \$1,000 today, but beginning at the start of next year and for each year thereafter, the perpetuity pays you \$80. Perpetuity B costs twice as much, \$2,000 today, but pays out \$150 every year starting next year. At what fixed interest rate would a risk neutral individual be indifferent between the two perpetuities?

b. (3 points) Firm 1 and Firm 2 both sell bonds in the bond market in order to raise money for research and development. The bonds offered by both firms have exactly the same payout stream. However, firm 1's bond costs more than that sold by firm 2. Which firm's bond has a higher interest rate (effective yield) and why would anyone buy the bond with the lower interest rate (effective yield)?

Question 7 (Chapter 17, 13 points)

Consider the market for used cars with two types: "Lemons" (cars with problems) and "Peaches" (cars without problems). Assume that a seller knows whether a car is a lemon or a peach, but a buyer cannot tell until the car is purchased. Suppose that the reservation price of a peach is $6,000 to the buyer, and $5,000 to the seller. The reservation price of a lemon is $2,000 to the buyer, and $500 to the seller.

a. (7 points) Suppose that buyers perceive that the probability of getting a lemon is 1/2. What is the equilibrium price of used cars in the market? What proportion of car sales are peaches?

b. (6 points) Continue to assume the market conditions in part (a), except that the probability of getting a lemon is now variable. Suppose that Peter starts a business to sell used cars with warranties. In particular, he buys all used cars in the market at $5,000 apiece (the reservation price of a peach's seller), and sells them at $6,000, of which $1,000 is the cost of the warranty. If the car is a lemon, he refunds the purchase price (that includes the warranty), and resells the lemon at $2,000 without a warranty. Assume that Peter is risk-neutral. For what range of probability of lemons is this business profitable for Peter?

Question 8 (Chapter 18, 10 points)

a. (7 points) Fire alarm factories operate outside small cities across America. The market for fire alarms is perfectly competitive. The market demand for fire alarms is $P = 200 - 10Q$. The industry supply curve (the horizontal sum of individual firm marginal cost functions) is given by $S = MC = 10Q$. The production process includes testing the fire alarms, which fills the surrounding neighborhoods with a loud noise several times a day. This annoyance has an aggregate marginal external cost to the neighbors equal to $MEC = 5Q$. Compute the optimal per unit tax on fire alarms to obtain the social optimum.

b. (3 points) Now suppose the government does not intervene, but the residents are assigned property rights to a quiet neighborhood. Discuss the outcome in a world with costless bargaining. Is this outcome likely to occur in reality? Why or why not?

Massachusetts Institute of Technology
Department of Economics

14.01 Principles of Microeconomics
Midterm Exam #3
Tuesday May 20th, 2008

Last Name (Please print): ______________

First Name: ___________________

MIT ID Number: ___________________

Instructions. Please read carefully.
The exam has a total of 100 points. **There are 8 questions, one from each chapter.** You have 120 minutes. Answers should be as concise as possible. This is a closed book exam. You are not allowed to use notes, equation sheets, books or any other aids. You are not allowed to use calculators. You must write your answers in the space provided between questions. DO NOT attach additional sheets of paper. This exam consists of 23 sheets (1 front page + 16 pages + 6 blank pages for scratch work). Please write your name on the blank pages if you use them.

Please circle the section or recitation which you are attending below. The marked exam will be returned to you in the section or recitation that you indicate.

R01: F10	(Jeanne LaFortune)	S01: MWF9	(Brandon Lehr)
R02: F11	(Jeanne LaFortune)	S02: MWF10	(Brandon Lehr)
R03: F12	(Monica Martinez-Bravo)	S03: MWF10	(David Walton Brown)
R04: F1	(Jeanne LaFortune)	S05: MWF11	(David Walton Brown)
R05: F1	(Monica Martinez-Bravo)	S06: MWF12	(Roger Ke)
R06: F2	(Monica Martinez-Bravo)	S07: MWF2	(HeiWai Tang)
		S09: MWF3	(HeiWai Tang)

DO NOT WRITE IN THE AREA BELOW:

Question 1 __ /20	Question 5 __ /10	
Question 2 __ /20	Question 6 __ /7	
Question 3 __ /12	Question 7 __ /13	
Question 4 __ /8	Question 8 __ /10	Total __ /100

Question 1 (Chapter 10, 20 points)
Consider a monopolist with a cost function $C(q) = 8q + q^2$, facing market demand $q = 20 - p$.

a. (5 points) Find the monopoly's profit-maximizing choice of quantity and price.

Revenue $(R) = p(q)\,q = (20 - q)\,q$
Marginal Revenue $(MR) = 20 - 2q$
Marginal Cost $(MC) = 8 + 2q$
A profit-maximizing monopoly sets $MR = MC \rightarrow 20 - 2q = 8 + 2q \rightarrow q_m = 3$. *Using the demand function,* $p_m = 17$.

b. (7 points) Calculate the deadweight loss of the monopoly.

First, we need to figure out the competitive equilibrium output and price. The competitive equilibrium is pinned down by the intersection between the marginal cost curve and the demand curve, i.e. $8 + 2q = 20 - q \rightarrow q^* = 4$*, with equilibrium price equal to* $p^* = 16$*. Therefore, the deadweight loss equals* $\frac{1}{2}(17 - 16)(4 - 3) = \frac{1}{2}$.

c. (8 points) Suppose that the government wanted the monopolist to produce the competitive equilibrium output. Would the government have to tax or subsidize the production of the monopoly? What level of per-unit tax or per-unit subsidy would the government have to impose on the monopoly? Assuming that the government imposed such a tax or subsidy, calculate the resulting deadweight loss.

Let t *be the tax on the monopoly. Thus,* $MC = 8 + 2q + t$*. If* t *is positive, the monopoly choice of quantity will decrease further away from the competitive one. Therefore,* $t < 0$*, i.e. a subsidy is needed in order to increase output closer to the competitive equilibrium.*

From (b), the competitive equilibrium output is 16. Given that the monopoly will set $MR(q) = MC(q) + t$*, we can back out* t *from the following equation*

$$\begin{aligned} 8 + 2(16) + t &= 20 - 2(16) \\ t &= -52. \end{aligned}$$

Although consumer and producer surpluses are both equal to their counterparts in a perfectly competitive market, deadweight loss is positive, and is equal to the government cost of subsidies $= 52(16) = 832$.

Question 2 (Chapter 11, 20 points)

a. (6 points) There are two types of golfers in a town. There are serious golfers who like to golf often. Each serious golfer has demand given by: $Q_1 = 100 - P$, where Q_1 is the number of rounds of golf per year and P is the fee for each round of golf. There are also recreational golfers, each of whom has a demand given by: $Q_2 = 40 - \frac{1}{2}P$. Assume there are 80 serious players and 10 recreational players in this town. The fixed cost of running the golf club is \$10,000 per year and the marginal cost of providing a round of golf to a customer is \$20. Assume that the golf club can distinguish serious and recreational players from each other and that the golf club can charge only for each round of golf. What prices should the golf club charge each type of player in order to maximize its total annual profit? How many rounds of golf will each type of golfer play per year?

Equating MR_1 and MR_2 with MC gives the solution:

$$MR_1 = 100 - 2Q_1 = 20 = MC$$

$$MR_2 = 80 - 4Q_2 = 20 = MC$$

Thus, $Q_1 = 40$ and $Q_2 = 15$. Plugging these quantities into their respective demand curves, yields an optimal third degree price discrimination scheme of $P_1 = 60$ and $P_2 = 50$.

b. (14 points) Now assume that the golf club cannot distinguish between serious and recreational players. However, the club can charge the same membership fee and the same price per round of golf to any player. What is the profit-maximizing membership fee? What is the profit-maximizing fee per round of golf? How many golfers of each type will play?

If the manager wants to exclude the recreational players and serve just the serious players, he will set $P = MC = 20$ and set the membership fee equal to the consumer surplus of the serious players. Thus $f = 0.5 * (100 - 20)^2 = 3200$. Thus, profits are given by \$3,200 $* 80 -$ \$10,000 $=$ \$246,000.

If the manager decides to serve both groups, he needs to set a price above marginal cost and the membership fee equal to the consumer surplus of the recreational golfer. The general maximization problem becomes

$$\max 90f + (P - 20) * (80 * (100 - P) + 10 * (40 - .5P)) - 10,000$$

where $f = .5 * (40 - .5P) * (80 - P)$.

Taking the first order condition with respect to P yields $P = 52, f = 196, Q_1 = 48, Q_2 = 14$. The corresponding profits are \$135,000. Thus, the manager would prefer to set a higher membership fee and lower price to serve only the serious golfers. It is optimal to exclude the recreational golfers, as their low willingness to pay restricts the size of the membership fee when the course wants to serve everyone. Since there are so many serious golfers, it is better to charge a higher membership fee and not serve the small recreational golfing market.

Question 3 (Chapter 12, 12 points)

a. (8 points) Consider two firms both selling soap. Their products are differentiated and they compete by choosing prices simultaneously. In particular, the demand functions for each firm are:

$$\begin{aligned} Q_1 &= 12 - 2P_1 + P_2 \\ Q_2 &= 12 - 2P_2 + P_1 \end{aligned}$$

Let marginal costs equal 0 for both firms. Both firms have no fixed costs. Determine the price that each firm will charge in a Nash equilibrium.

We need to solve for each firm's best response functions and then find their intersection.

$$\text{Firm 1 chooses } P_1 \text{ to solve: } \max P_1(12 - 2P_1 + P_2)$$

$$\text{Firm 2 chooses } P_2 \text{ to solve: } \max P_2(12 - 2P_2 + P_1)$$

Firm 1's best response function: $P_1 = 3 + \frac{P_2}{4}$ *Firm 2's best response function:* $P_2 = 3 + \frac{P_1}{4}$ *The Nash Equilibrium is* $P_1 = P_2 = 4$

b. (4 points) Suppose that firm 1 sets the price of its soap first, and then firm 2 sets the price of its product second. After the two firms set their prices, there can be no further price changes. Determine the new equilibrium price for each firm. Explain whether the following statement is True or False: In comparison to the simultaneous-move game in part (a), firm 1 attains a greater increase in profit than firm 2 because firm 1 can now move first.

To solve, we plug firm 2's best response function into firm 1's profit function and then maximize with respect to P_1.

$$\max P_1(12 - 2P_1 + 3 + \frac{P_1}{4})$$

This gives $P_1 = \frac{30}{7}$ *and plugging this into firm 2's best response function gives* $P_2 = \frac{57}{14}$. *Although there is a first mover advantage in Cournot competition, in price competition there is an advantage to moving second. Revealing price first allows the second price setter to undercut the first mover and do relatively better. Thus, moving second means that firm 2's profits will increase by more than firm 1's profits relative to the simulataneous Nash equilibirum.*

Question 4 (Chapter 13, 8 points)
Consider the following two player game where the first number in each box is Player 1's payoff and the second number is Player 2's payoff:

		Player 2	
		Left	Right
Player 1	Top	2 , 5	3 , 5
	Bottom	4 , a	b , 0

a. (2 points) For what value of b does Player 1 have a dominant strategy?

For $b > 3$, Bottom is a dominant strategy for Player 1.

b. (3 points) Using the condition you found in part (a), what additional conditions on a will give a unique Nash Equilibrium in the above game?

With $b > 3$, there is a unique Nash Equilibrium of the game if:

(1) $a > 0$, in which case (B,L) is the unique NE
(2) $a < 0$, in which case (B,R) is the unique NE

c. (3 points) Find conditions on the constants a and b in the above game such that there are three (pure strategy) Nash Equilibria.

There are three Nash Equilibria if $a = 0$ and $b = 3$, in which case all but (T,L) are pure strategy NE.

Question 5 (Chapter 14, 10 points)
a. (6 points) A firm uses a single input, labor L, in a competitive labor market to produce output q according to the production function

$$q = 4\sqrt{L} + \frac{1}{3}L$$

The output sells on a competitive market at a price of $40 per unit and the wage is $20 an hour. Find the profit maximizing quantity of L and q.

The optimal choice of labor is found by equating the wage with the marginal revenue product of labor.

$$20 = w = MRP_L = P * MP_L = 40 * (\frac{2}{\sqrt{L}} + \frac{1}{3})$$

Solving this equation gives $L = 144$. And plugging this back into the production function gives $q = 96$.

b. (4 points) Assume that everything in the above setup is unchanged, except that now the firm is a monopolist in the output market. Explain how this will affect the firm's demand for labor in the input market.

The firm will still set the marginal revenue product of labor equal to the wage, but now $MRP_L = MR * MP_L$ *and since* $MR < P$ *(for profit maximizing output levels) in a monopolistic output market, the firm will hire less labor.*

Question 6 (Chapter 15, 7 points)

a. (4 points) Consider two perpetuities (bonds that pay out a fixed amount of money each year, forever). Perpetuity A costs $1,000 today, but beginning at the start of next year and for each year thereafter, the perpetuity pays you $80. Perpetuity B costs twice as much, $2,000 today, but pays out $150 every year starting next year. At what fixed interest rate would a risk neutral individual be indifferent between the two perpetuities?

We need to find the interest rate, R, that equates the PDVs of the two perpetutites.

$$PDV_A = -1000 + \frac{80}{R} = -2000 + \frac{150}{R} = PDV_B$$

The solution to this equation is $R = 0.07$*, so the interest rate must be 7% for the buyer to be indifferent.*

b. (3 points) Firm 1 and Firm 2 both sell bonds in the bond market in order to raise money for research and development. The bonds offered by both firms have exactly the same payout stream. However, firm 1's bond costs more than that sold by firm 2. Which firm's bond has a higher interest rate (effective yield) and why would anyone buy the bond with the lower interest rate (effective yield)?

Firm 1's bond has a lower effective yield since it costs more money for the same payout stream. If the bonds offered by the two firms were of the same risk category, then no one should ever buy the lower yield bond of firm 1. However, if the ability of firm 2 to meet its debt obligations is more uncertain than that of firm 1, firm 2's bonds are more risky and thus must provide a larger effective yield in order to induce individuals to buy the bond. Thus, a very risk averse person would still buy firm 1's more expensive bond to avoid the higher risk and return associated with the bond from firm 2.

Question 7 (Chapter 17, 13 points)

Consider the market for used cars with two types: "Lemons" (cars with problems) and "Peaches" (cars without problems). Assume that a seller knows whether a car is a lemon or a peach, but a buyer cannot tell until the car is purchased. Suppose that the reservation price of a peach is \$6,000 to the buyer, and \$5,000 to the seller. The reservation price of a lemon is \$2,000 to the buyer, and \$500 to the seller.

a. (7 points) Suppose that buyers perceive that the probability of getting a lemon is 1/2. What is the equilibrium price of used cars in the market? What proportion of car sales are peaches?

Equilibrium price is equal to the expected reservation price of used cars to a buyer $= \frac{1}{2}(\$6,000) + \frac{1}{2}(\$2,000) = \$4,000$. *Since the equilibrium price is lower than the reservation price of peaches, no peach will be sold in the market. The proportion of peaches is 0.*

b. (6 points) Continue to assume the market conditions in part (a), except that the probability of getting a lemon is now variable. Suppose that Peter starts a business to sell used cars with warranties. In particular, he buys all used cars in the market at $5,000 apiece (the reservation price of a peach's seller), and sells them at $6,000, of which $1,000 is the cost of the warranty. If the car is a lemon, he refunds the purchase price (that includes the warranty), and resells the lemon at $2,000 without a warranty. Assume that Peter is risk-neutral. For what range of probability of lemons is this business profitable for Peter?

Let p be the probability of getting a lemon. With probability p, Peter pays $5,000 for a lemon, and has to refund a full amount of the initial sales, and sells it at the lemon price, $2000. With probability $1-p$, Peter pays $5,000 for a peach, sells it at a price of $6,000. In expectation, this business is profitable if the following inequality holds.

$$p\,(\$2,000 - \$5,000) + (1-p)\,(\$1,000) > 0,$$

which can be simplified to $p < \frac{1}{4}$.

Question 8 (Chapter 18, 10 points)

a. (7 points) Fire alarm factories operate outside small cities across America. The market for fire alarms is perfectly competitive. The market demand for fire alarms is $P = 200 - 10Q$. The industry supply curve (the horizontal sum of individual firm marginal cost functions) is given by $S = MC = 10Q$. The production process includes testing the fire alarms, which fills the surrounding neighborhoods with a loud noise several times a day. This annoyance has an aggregate marginal external cost to the neighbors equal to $MEC = 5Q$. Compute the optimal per unit tax on fire alarms to obtain the social optimum.

The optimal tax should equal the marginal external cost at the socially optimal output level. To find the social optimum, we need to set the marginal social cost equal to the demand curve.

$$MSC = MC + MEC = 10Q + 5Q = 15Q = 200 - 10Q = P$$

Solving this equation yields $Q = 8$ at the social optimum. Hence, the optimal tax should equal $40 per fire alarm. This will force the firm to internalize the negative externality it is imposing on the neighbors and restrict output.

b. (3 points) Now suppose the government does not intervene, but the residents are assigned property rights to a quiet neighborhood. Discuss the outcome in a world with costless bargaining. Is this outcome likely to occur in reality? Why or why not?

If the residents are assigned property rights to a quiet neighborhood and bargaining is costless, the Coase Theorem tells us that residents could demand that the firm pay them for the right to test their fire alarms. This would force the firm to internalize the costs of testing the fire alarms without government intervention, and a socially optimal solution would be achievable. This is not likely to occur in the real world, however, for many reasons. It does cost time and money to bargain, so these additional costs could prevent obtaining the optimal equilibrium. Also, it may be difficult for residents to actually determine the marginal external cost imposed on them. Moreover, having property rights to a "quiet" neighborhood is difficult to define in practice and with many people in a town, bargaining is more difficult.

1401

~~Income vs substitution effects~~

~~Past exams~~

~~Midyear exams~~

~~Cournot math~~

14.01 Debreif

12/15

Much harder than I expected

Did not think I did well

Did figure a lot of the stuff out on the finals

But some things still confused over

Could have had <u>more</u> pratice w/ #

But that is problem of 2 finals in 1 day