

**OVERVIEW:** Microeconomics is the study of the interactions that happen between individuals (defined broadly to include buyers, sellers, governments and firms) that determine what is produced and how economic benefits are distributed. In the introductory course you learned about how economists view the world and how they formulate theories about how the economy works at the level of the individual. In this course we get into the details. In doing so, we will use a lot of math, not just to complicate things, but to teach you the tools that economists use to analyze and solve real problems.

**REQUIRED TEXT:** The book that we will use for the course should be available at the main bookstore. It is: *Intermediate Microeconomics with Calculus* by Hal Varian.

**HOMEWORK:** There will be 8 to 10 homework assignments. All the homework problems are attached to this syllabus. The course schedule on the second page sets the due dates for each problem set. The purpose of these problem sets is to help you further understand the material covered in class and to prepare you for the exams. I encourage you to discuss how to solve the problem sets with others in the class or come see me if you get stuck. I will not accept late homework assignments so do not wait until the last minute to begin.

**TUTORIALS:** I have scheduled tutorials for Monday afternoons (from 12:30 to 1:20). These sessions have been included to (i) go over tricky aspects of the problem sets, (ii) hold review sessions and (iii) provide a venue to discuss other topics that might arise along the way.

**EXAMS:** To maintain a level playing field, the department has decided that instructors will proctor exams in the core courses.

**GRADING:** Your performance in the class will depend on how well you do on the homework and four exams (three midterms and a final) all of equal length and weight. All exams are closed book. The midterm exams are not cumulative, but the final exam is. The in-class midterm dates are written on the class schedule (see the next page) and are not negotiable. However, people may get sick and miss an exam. With this in mind, only your best three exams scores will count towards your grade. Also, you need to plan to be here during finals week because the final exam date for this course is also not negotiable.

Everything you do for this course will be graded on a 100 point scale. Your final grade for the course will be the weighted average:  $[90\% \times (\text{your best three exams})] + [10\% \times (\text{homework})]$ . You will receive a numerical and a letter grade on each assignment or test. The letter grade will depend on how well you do compared to the rest of the class. There is no explicit curve used to determine letter grades; instead, after each assignment or test I will look for natural breaks in the numerical grades to assign letter grades.

## SCHEDULE OF TOPICS

Week	Date	Homework due	Topic	Book Chapter
1	9/12		<i>No meeting</i>	Tutorial
1	9/13		Math Preparation – partial derivatives	Handout
1	9/15		The Market	1
2	9/19		<i>Calculus refresher</i>	Tutorial
2	9/20		The Budget Constraint	2
2	9/22	1: chps. 1&2	Preferences	3
3	9/26		<i>Problem sets and further examples</i>	Tutorial
3	9/27		Utility	4
3	9/29	2: chps. 3&4	Choice	5
4	10/3		<i>Problem sets and further examples</i>	Tutorial
4	10/4		more choice	5
4	10/6	3: chp. 5	<b>First Midterm Exam (in class)</b>	<b>1-5</b>
5	10/10		<i>Go through Exam 1</i>	Tutorial
5	10/11		Demand	6
5	10/13		Time Preferences and Discounting	10
6	10/17		<i>No meeting – midterm recess</i>	Tutorial
6	10/18	4: chp. 6	Inter-temporal Choice	10
6	10/20		Risk Preferences	12
7	10/24		<i>Problem sets and further examples</i>	Tutorial
7	10/25		Uncertain Choice	12
7	10/27	5: chp. 10, 12	Market Demand	15
8	10/31		<i>Problem sets and further examples</i>	Tutorial
8	11/1		Equilibrium	16
8	11/3		<i>No meeting – Prof. at the NSF</i>	-
9	11/7		<i>Problem sets and further examples</i>	Tutorial
9	11/8	6: chp. 15, 16	<b>Second Midterm Exam (in class)</b>	<b>6, 10, 12, 15, 16</b>
9	11/10		Technology	19
10	11/14		<i>Problem sets and exam 2</i>	Tutorial
10	11/15		Profit Maximization	20
10	11/17	7: chp. 18,19	Monopoly	25
11	11/21		<i>Problem sets and further examples</i>	Tutorial
11	11/22		Oligopoly	28
12	11/24		<i>No meeting - Thanksgiving</i>	
12	11/28		<i>Problem sets and further examples</i>	Tutorial
12	11/29	8: chp. 24, 27	more Oligopoly	28
12	12/1		<b>Third Midterm Exam (in class)</b>	<b>19, 20, 25, 28</b>
13	12/5		<i>Problem sets and exam 3</i>	Tutorial
13	12/6		Game Theory	29
13	12/8	9: chp. 28, 17	Auctions	18

Microeconomic Theory (Econ 255)  
Homework Problems

Chapters 1 and 2:

- 1) Consider trying to sell your junky old car on the used car market. Some people love old cars, see restoration potential in them and therefore have high *reservation prices*. Others see them as quick fixes when their other car breaks suddenly. The latter group just needs a car quickly and is not willing to pay much for a car. Hence, they have low reservation prices.

The following list of numbers is a list of the reservation prices of the 7 people who are currently looking to buy a used car similar to yours: 1000, 900, 800, 750, 740, 300, 150.

- (a) Draw the demand curve for your used car (note: you can't sell a fraction of a car).
- (b) Say you value your used car at 100 for sentimental reasons. If you are able to auction off your car in (1) an ascending price (English) auction or (2) a descending price (Dutch) auction, what price would you get? Draw another graph with the market supply curve to support your prediction.
- (c) Now say you have 3 old cars (same model and year but different condition). You value the first at \$50, the second at \$100 and the third at \$150. If you auction them off using the English auction (and the demand is the same as above) how much revenue would you expect to get?
- 2) Suppose the demand for some market can be expressed by the following relationship between the quantity demanded and price:  $q=10-(p/5)$  and the supply curve for this market is  $q=(p-8)/2$ .
- (a) Graph the market demand and supply functions.
- (b) Algebraically find the market equilibrium price and quantity.
- 3) Now suppose the market demand is  $q=19.5-2p$  and supply is  $q=3p-18$ .
- (a) Graph the market demand and supply functions.
- (b) Algebraically find the market equilibrium price and quantity.
- 4) Now suppose the market demand is  $q=10/p$  and supply is fixed at 12 units (i.e.  $q=12$ ).
- (a) Graph the market demand and supply functions.
- (b) Algebraically find the market equilibrium price and quantity.
- 5) One last market question. Suppose the market demand is  $q=15/p$  and supply is  $q=(p-2)/2$ .

- (a) Graph the market demand and supply functions.
  - (b) Algebraically find the market equilibrium price and quantity.
- 6) Eddie has \$10 to spend on meatball sandwiches, good X, and root beer sodas, good Y.
- (a) If the price of a meatball sandwich is \$5 and the price of root beer is \$2, formulate and plot Eddie's budget constraint.
  - (b) Assume the price of root beer decreases to \$1. Formulate and plot his new budget constraint.
  - (c) Suppose Eddie's income doubles to \$20 and the prices of the good are the same as in (a). What is the new budget constraint. Plot it.
- 7) There are two goods that a consumer can buy. The price of good one is 5, and the price of good two is 3. In addition, the consumer's income is 45.
- (a) What is the equation of the consumer's budget constraint?
  - (b) Graph the budget constraint.
  - (c) Suppose a tax of 50 cents *per unit* is imposed on good 1, how does this change the equation of the consumer's budget constraint? How does it change the graph?
  - (d) Now suppose (on top of the tax) the consumer has a 50% increase in their income, half of which she saves and the other half she spends, what is the new budget constraint?
  - (e) Starting from (d), what if the consumer could only spend their increased income on good 1? How does this change the budget constraint? Graph the change.

Chapters 3 and 4:

- 1) Charlie likes both apples and bananas. He consumes nothing else. The consumption bundle where Charlie consumes  $x_A$  bushels of apples per year and  $x_B$  bushels of bananas per year is written as  $(x_A, x_B)$ . Last year, Charlie consumed 20 bushels of apples and 5 bushels of bananas. It happens that the set of consumption bundles  $(x_A, x_B)$  such that Charlie is indifferent between  $(x_A, x_B)$  and  $(20, 5)$  is the set of all bundles such that  $x_B=100/x_A$ , the set of bundles  $(x_A, x_B)$  such that Charlie is just indifferent between  $(x_A, x_B)$  and the bundle  $(10, 15)$  is the set of bundles such that  $x_B=150/x_A$ .
  - (a) On a graph, plot several points that lie on the indifference curve that passes through the point  $(20, 5)$ , and sketch this curve (i.e. connect the dots). On the same graph plot points for the indifference curve that passes through  $(10,15)$ .
  - (b) Redraw the graph from (a). Now add two things: 1) shade in the set of bundles that Charlie weakly prefers to the bundle  $(10, 15)$ . 2) Use a different color to shade in the set of commodity bundles such that Charlie weakly prefers  $(20,5)$  to these bundles.
  - (c) You should be able to use your graph to answer the following questions.
    - Is  $(30, 5) \sim (10, 15)$ ?
    - Is  $(10, 15) \succ (20, 5)$ ?
    - Is  $(20, 5) \succeq (10, 10)$ ?
    - Is  $(24, 4) \succeq (11, 9.1)$ ?
    - Is  $(11, 14) \succ (2, 49)$ ?
    - Is the set of bundles that Charlie weakly prefers to  $(20, 5)$  a convex set?
    - Is the set of bundles that Charlie considers inferior to  $(20, 5)$  a convex set?
    - What is the Marginal rate of Substitution at the point  $(10, 10)$ ?
    - What is the Marginal rate of Substitution at the point  $(5, 20)$ ?
- 2) Ambrose consumes only nuts and berries. Fortunately, he likes both goods. The consumption bundle where Ambrose consumes  $x_1$  units of nuts per week and  $x_2$  units of berries per week is written as  $(x_1, x_2)$ . The set of consumption bundles  $(x_1, x_2)$  such that Ambrose is indifferent between  $(x_1, x_2)$  and  $(1, 16)$  is the set of bundles such that  $x_1 \geq 0$ ,  $x_2 \geq 0$ , and  $x_2=20-4x_1^{1/2}$ . The set of bundles  $(x_1, x_2)$  such that  $(x_1, x_2) \sim (36, 0)$  is the set of bundles such that  $x_1 \geq 0$ ,  $x_2 \geq 0$ , and  $x_2=24-4x_1^{1/2}$ .
  - (a) On a graph, plot several points that lie on the indifference curve that passes through the point  $(1,16)$ . Do the same thing for the indifference curve passing through the point  $(36,0)$ .
  - (b) Shade in the set of bundles that Ambrose weakly prefers to the bundle  $(1,16)$ . Use another color to shade in the set of bundles  $(x_1, x_2)$  such that Ambrose weakly prefers  $(36,0)$  to these bundles. Is the set of bundles that Ambrose prefers to  $(1,16)$  a convex set?
  - (c) What is the slope of Ambrose's indifference curve at the point  $(9,8)$ ?
  - (d) What is the slope of Ambrose's indifference curve at the point  $(4, 12)$ ?
  - (e) What is the slope of Ambrose's indifference curve at the point  $(9, 12)$ ?
  - (f) Do the indifference curves you have drawn for Ambrose exhibit *diminishing marginal rate of substitution*? Why or why not?

- (g) Does Ambrose have *convex preferences*? Why or why not?
- 3) Here is a warm-up exercise. Find the marginal utility of good 1,  $MU_1$ , the marginal utility of good 2,  $MU_2$ , and the marginal rate of substitution, MRS for the following utility functions.
- (a)  $U(x_1, x_2) = 2x_1 + 3x_2$
- (b)  $U(x_1, x_2) = 4x_1 + 6x_2$
- (c)  $U(x_1, x_2) = ax_1 + bx_2$
- (d)  $U(x_1, x_2) = 2x_1^{1/2} + x_2$
- (e)  $U(x_1, x_2) = \ln x_1 + x_2$
- (f)  $U(x_1, x_2) = v(x_1) + x_2$  where  $v(\cdot)$  is some unspecified function of  $x_1$ .
- (g)  $U(x_1, x_2) = x_1 x_2$
- (h)  $U(x_1, x_2) = x_1^a x_2^b$
- (i)  $U(x_1, x_2) = (x_1 + 2)(x_2 + 1)$
- (j)  $U(x_1, x_2) = (x_1 + a)(x_2 + b)$
- (k)  $U(x_1, x_2) = x_1^a + x_2^a$
- 4) Mary's utility function is  $u(x, y) = \max\{x, 2y\}$ .
- (a) On a graph, draw and label the indifference curve where  $u(x, y) = 10$ .
- (b) Does Mary have convex preferences? Why or why not?
- 5) Ann has a utility function given by  $u(x_1, x_2) = x_1^2 + 2x_1 x_2 + x_2^2$ .
- (a) Compute Ann's marginal rate of substitution,  $MRS(x_1, x_2)$ .
- (b) Ann's cousin, Andrew, has a utility function  $v(x_1, x_2) = x_2 + x_1$ . Compute, Andrew's MRS.
- (c) Do  $u(x_1, x_2)$  and  $v(x_1, x_2)$  represent the same preferences?

Chapter 5:

- 1) We begin with Charlie who likes  $x$  and  $y$ . Say Charlie's preferences for these two commodities can be described by the following utility function,  $U(x, y) = xy$ . Further, suppose the current market price of  $x$  is 1, and the price of  $y$  is 2. Lastly, say Charlie's income is 40.
  - (a) On a graph draw Charlie's Budget Constraint. On the same graph draw two indifference curves that represent utility equal to 150 and 300.
  - (b) Can Charlie afford any bundles that give him utility of 150? Can he afford any bundles that give him a utility level of 300?
  - (c) Neither of the two ICs you drew was tangent to Charlie's budget constraint. Let's try to find one that is. At any point on an IC, Charlie's *marginal rate of substitution (MRS)* is a function of  $x$  and  $y$ . We learned that you can use the marginal utilities of  $x$  and  $y$  to find this function. What is the MRS? Recall that the MRS is the slope of an indifference curve, and the consumer will gain the most affordable utility by picking the point where the highest IC is just touching the BC. This will occur where this IC is just tangent to the BC. Mathematically, this means that these two lines are tangent or have the same slope at this point. Well, we have the slope of any IC (the MRS) now all we need is the slope of the BC. What is the slope of the BC (give a numerical answer)?
  - (d) Write an equation that implies that the budget constraint is tangent to an indifference curve. (Note, there are many such points, one corresponding to each level of income and utility). Put this equation in the form  $y = f(x)$  and plot it on a new graph with the BC and the two ICs. Notice, this equation is the locus of all point where the BC is tangent to some IC which means Charlie will choose one of these. In words, which one will he choose?
  - (e) Let's figure out his choice. Charlie's income is 40. If he uses all his income to buy these two commodities he will consume on the BC. Hence, his choice is constrained to be on two lines, the one that you derived in (d) and his BC. Find the intersection of these two lines -this is his choice.
  - (f) What is Charlie's level of utility at his choice?
- 2) Recall there are two ways to speed up the process of finding a consumer's optimal choice given a utility function, prices, and income. One way is the direct substitution of the BC into the utility function and do unconstrained maximization and the second is to form the Lagrange function and do constrained optimization. Being able to do this is one of the major goals of this course so let's practice.
  - (a) Direct Substitution - Suppose a consumer's utility of consuming  $x$  and  $y$  can be represented by  $U(x,y) = xy$ , the price of  $x$  is 6, the price of  $y$  is 3, and the consumer's income is 24. Use the direct substitution approach to find  $x^*$  and  $y^*$ .
  - (b) Direct Substitution - Suppose a consumer's utility of consuming  $x$  and  $y$  can be represented by  $U(x,y) = 8x + 4xy$ , the price of  $x$  is 1, the price of  $y$  is 1, and the consumer's income is 12. Use the direct substitution approach to find  $x^*$  and  $y^*$ .
  - (c) Lagrange - Suppose again that the consumer's utility of consuming  $x$  and  $y$  can be represented by  $U(x,y) = xy$ , the price of  $x$  is 6, the price of  $y$  is 3, and the consumer's income is 24. Use the Lagrange approach to find  $x^*$  and  $y^*$  and show that this is the same solution as in (a).
  - (d) Lagrange - Suppose a consumer's utility of consuming  $x$  and  $y$  can be

represented by  $U(x,y)=8x+4xy$ , the price of  $x$  is 1, the price of  $y$  is 1, and the consumer's income is 12. Use the Lagrange approach to find  $x^*$  and  $y^*$  and show that this is the same solution as in (b).

- 3) Complements and Choice - recall that the IC for complements have hard corners which means we can't use calculus to find the consumer's choice bundle (what's the derivative at a hard corner? Note, this is a rhetorical question). Here is an example, let Max's preferences for  $x$  and  $y$  be  $U(x,y)=\min\{x, 3y\}$ . Further, say the prices of  $x$  and  $y$  are 2 and 3 respectively, and her income is 12.

(a) What is the ratio in which Max consumes  $x$  and  $y$ ? On a graph, draw some representative ICs for Max. Draw a line connecting all the points at the hard corner of these ICs. What is the equation of the line that passes through these points (hint: it has something to do with the ratio you calculated)?

(b) Just like in problem 1 we can use this line and the BC to determine Max's favorite affordable bundle. That is, the solution  $(x^*, y^*)$  will lie at the intersection of these two lines. Find  $x^*$  and  $y^*$ .

(c) What is Max's level of utility?

- 4) Substitutes and Choice - Substitutes are the other extreme. That is, you consume either  $x$  or  $y$  depending on which one is cheapest. Let's show this more formally. Suppose Chris considers  $x$  and  $y$  to be substitutes, but not perfectly so. His utility function is  $U(x,y)=2x+y$  so  $x$ s are worth twice a  $y$ . Let the price of  $x$  be 3 and the price of  $y$  be 5. His income is 60.

(a) Graph the BC and some representative ICs where  $U=12$  and  $U=40$ . This should be enough to tell you whether Chris chooses  $x$  or  $y$ , but let's proceed. Explain, in words, why this graph is enough to answer the choice question.

- 5) Demands - Let's go back to Charlie. Recall his preferences were  $U(x, y)=xy$ . Now to see where a demand function for an individual comes from we will make things more general. Now say the price of  $x$  is  $p_x$  and the price of  $y$  is  $p_y$ . Lastly, let Charlie's income be  $m$ . This means Charlie's BC is now  $p_x x + p_y y = m$  (assuming all his money is spent).

(a) Treat prices and income as constants and use the Lagrange method to find  $x^*$  and  $y^*$ . These will be Charlie's demands for  $x$  and  $y$  at any prices  $(p_x, p_y)$  and income level,  $m$ .

(b) Graph Charlie's demand for  $x$  using standard axes (price and  $x$ ). Is his demand downward sloping? How can you prove that demand is downward sloping? What happens to the demand curve you have drawn if income rises from  $m$  to  $m'$ ?



Chapter 6:

- 1) Donald is a stamp collector. The only things other than stamps the Don consumes are Hostess Twinkies. It turns out that Don's preferences can be represented by  $U(s,t)=s+\ln(t)$  where  $\ln$  is the natural log. The price of stamps is  $p_s$  and the price of Twinkies is  $p_t$ . Don's income is  $m$ .
  - (a) Find Don's demand for stamps and Twinkies using the Lagrange method (note the derivative of  $\ln(x)$  is  $1/x$ ). What is weird about his demand for Twinkies?
  - (b) Don's wife complains that whenever Don gets an extra dollar, he always spends it on stamps. Is she right? How can you show this using his demand functions (assume  $m > p_s$ ).
  - (c) Suppose the price of Twinkies is 2 and the price of stamps is 1. On a graph, draw Don's Engel curve for Twinkies and his Engel curve for Stamps (hint: first draw the Engel curve for incomes greater than 1, then draw them for incomes less than 1).
  
- 2) Find an expression for and graph the demands for the two commodities in the following two scenarios. Also graph the Engel curve for  $x$  if  $p_x=p_y=1$ .
  - (a) Complements:  $U(x,y) = \text{Min}\{ax, by\}$  where  $a, b > 0$ .
  - (b) Substitutes:  $U(x,y) = x+4y$ .

Chapter 10:

- 1) Say a consumer has the following endowment of income in each of two time periods,  $(m_1, m_2) = (10, 5)$ . Further, she can borrow or lend at interest rate,  $r$ , and she has an inter-temporal utility function of  $u(c_1, c_2) = \ln(c_1) + \ln(c_2)$ .
  - (a) What is the equation of her budget constraint?
  - (b) How much does the consumer decide to consume in each of the two time periods?
  - (c) If the interest rate is 10%, is she a borrower or a lender?
  - (d) Let's complicate things a little. Say that the consumer will need to pay taxes on any interest income that she accrues. Let the tax rate be  $t$ . Hence, if she saves  $X$  dollars she will earn  $rX$  in interest income but will have to pay  $trX$  in taxes. How does this change the consumer's consumption in the two periods (i.e. calculate the new consumption levels where the interest rate is  $r$ )?
  - (e) Now let's see if the consumer has changed her behavior from (c). Let the interest rate again be 10%, but now let the tax rate be 65%. Is she a borrower or a lender?
  
- 2) Here is a series of present value questions to warm-up on.
  - (a) What is the present value of \$100 one year from now if the interest rate is 10%? What if the interest rate is 5%?
  - (b) How much is \$1 million to be delivered 20 years in the future worth today if the interest rate is 20 percent?
  - (c) What is the most you would ever be willing to pay for a bond that has the following income stream. The bond pays fixed payments (coupon payments) of 10 dollars each year until it matures in 15 years at which point you receive the face value of the bond which is 150 dollars. Say the current interest rate is 5% per year.
  - (d) How much would you pay for a consol (defined in the book) that pays \$5.00 forever?
  
- 3) Now we have a harder present value problem. Say you find yourself in a repeated interaction (repeated forever) with some other person. You have two possible strategies to follow. You can either cooperate with this other person or try to cheat them. Say you both get a payoff,  $\alpha$ , every time you cooperate with each other. However, you can get away with cheating your partner once. If you cheat your partner you get  $\beta$  in the first interaction, but you destroy trust and get  $\delta$  for all future interactions. Say the payoffs are ordered such that  $\delta < \alpha < \beta$ . If the interest rate is  $r$ , find the  $r, r^*$  such that you are indifferent between cheating on your partner and cooperating forever (note: imagine you play this game for the first time today, in which case, you do not discount the first payoff you receive).

Chapter 12:

- 1) Say you have 50 dollars in your pocket and are thinking of buying a lottery ticket which costs 5 dollars and pays 100,000 dollars if you win. There are a total of 20,000 tickets that will be sold.
  - (a) Say you are risk neutral. Will you buy a ticket?
  - (b) Now say your utility for money is  $u(\text{wealth}) = \ln(\text{wealth})$ . Are you risk averse? Why? Now will you buy the ticket?
  - (c) Graph your utility for wealth from (b). Add the decision that you face - whether to buy the lottery ticket or not. On the graph indicate how much you would be willing to pay to avoid such a gamble.
  - (d) Can you figure out how much you would pay for insurance to avoid such a gamble? Your answer should be a dollar amount.
  
- 2) Assume that a consumer has \$50,000 in wealth, but might lose it all. Such a loss occurs four times in ten. Say she can insure against losses at a premium of  $\gamma$  per K dollars of insurance (note:  $0 < \gamma < 1$ ). Finally, say she has the following preferences for wealth,  $u(c_g, c_b) = \pi \ln(c_g) + (1-\pi) \ln(c_b)$  where  $c_g$  is consumption in the good state,  $c_b$  is consumption in the bad state and  $\pi$  is the probability that the good state occurs.
  - (a) What is the value of  $\pi$  from the above information?
  - (b) What is the consumer's budget constraint?
  - (c) Find the consumer's optimal choice of  $c_b$  and  $c_g$ .
  - (d) Now let  $\gamma = 0.5$ . Find values for  $c_b^*$  and  $c_g^*$ . Does the consumer buy or sell insurance? If they buy, how much insurance do they buy and what do they pay for it?
  - (e) Graph the consumer's choice in  $(c_b, c_g)$  space. If they are fully insured, how much insurance would they buy?

Chapter 15:

- 1) Consider two people in the market for widgets. Let the demand of person one be  $x_1(p) = 24 - 2p$  and say the demand for the second person is  $x_2(p) = 10 - p$ .
  - (a) Graph the demands for the two individuals.
  - (b) Graph the market demand.
  - (c) What is the equation for the market demand?
  
- 2) Consider the following linear market demand curve,  $q = (a/b) - (p/b)$ .
  - (a) What is the price elasticity of demand?
  - (b) At which quantity does the price elasticity equal -1?
  - (c) What is the equation of the marginal revenue curve?
  - (d) At what value of  $q$  does revenue attain its maximum value? What is this value?
  - (e) Graph the relationship between demand, marginal revenue and revenue (i.e. show all the points you have found in letters (b) thru (d)).

Chapter 16:

- 1) Let supply and demand be described by  $q=1+(3p/5)$  and  $q= 24-2p$  respectively.
  - (a) Graph Supply and Demand and analytically find the equilibrium market price.
  - (b) Is this price equilibrium *stable*?
  
- 2) Let supply and demand be described by  $q=4+(1p/4)$  and  $q= 2+(1p/3)$  respectively.
  - (a) Graph Supply and Demand and analytically find the equilibrium market price. What kind of good must this be?
  - (b) Is this price equilibrium *stable*?
  
- 3) Let market demand be given by  $q=75/p$  and let supply be linear,  $q=p-4.5$ . Say there is a tax of \$1.5 per unit sold which is collected by the seller.
  - (a) What is the initial price equilibrium (i.e. before the tax)?
  - (b) What is the price equilibrium after the tax?
  - (c) What is the Dead Weight Loss due to the tax (this answer should be a number)?

Chapter 31: (Skip, we won't be covering this)

Consider two individuals, Eye and Jay, who are each endowed with an amount of two commodities (let's call them xylophones and yams). Each individual has an identical utility function  $U=xy$ , where  $x$  is the amount of xylophones they consume (not eat) and  $y$  is the amount of yams they consume (presumably eat). Let's say that Eye's endowment consists of 1 xylophone and  $3/2$  yams. Likewise, Jay's endowment is 1 xylophone and  $1/2$  yams. Now suppose Eye and Jay realize that they might be able to mutually gain by trading with each other.

- (a) Draw in two separate diagrams with xylophones on the  $x$  axis and yams on the  $y$  axis the indifference curves of the two individuals for arbitrary levels of utility (e.g.  $U=1,4,9$ ). Indicate a point representing each individual's endowment on these two graphs.
- (b) Draw an Edgeworth box diagram of the initial endowments and the lens of agreements which would make both Eye and Jay better off. Draw it so that Eye is in the lower left corner, Jay is in the upper right, xylophones on the  $x$ -axis and yams on the  $y$ -axis.
- (c) Write a definition of the Contract Curve. Next, write out the expression for the contract curve in terms of the two goods,  $x$  and  $y$ . Lastly, redraw your Edgeworth box diagram so that it includes the contract curve.
- (d) Assume each individual maximizes his/her utility subject to his/her budget constraint where utility is determined by the amounts of  $x$  and  $y$  and the prices of  $x$  and  $y$ . From the Lagrange method figure out the demands of each individual for  $x$  and  $y$  in terms of prices and income,  $m$ .
- (e) We know that if Eye and Jay agree to use the market price mechanism they can move from the endowment point to a point on the contract curve where both are better off in utility terms. Find the final allocation of  $x$  and  $y$  that would be the result of the market.
- (f) Prove that the market allocation makes both Eye and Jay better off. (Hint: think utility).

Chapter 19:

- 1) Consider the following production functions (functions of capital,  $K$  and labor,  $L$ ) and tell me whether they exhibit increasing, constant, or decreasing returns to scale.
  - (a)  $y = 2K^2L^2$
  - (b)  $y = 4K^{1/2}L^{1/2}$
  - (c)  $y = K+L$
  - (d)  $y = 10(K+L)$
  - (e)  $y = \min\{3K, 2L\}$
- 2) What are the marginal products of capital and labor for the five production functions in 1(a)-(e)?
- 3) What are the Marginal Rates of Technical Substitution (MRTS) for each of the production functions in 1(a)-(e)?
- 4) Graph the isoquant where  $y=10$  for each of the production functions in 1(a)-(e).
- 5) Prove that Monotonicity implies that isoquants slope downward.
- 6) Say there is a production process in which Social Capital,  $s$ , interacts with technology such that the production function can be described by  $y=LK^\alpha+A^sL^\beta$ . For positive levels of trust,  $1 < s < 2$  and for negative levels of trust we have  $0 < s < 1$ . How does the level of Social Capital affect the marginal product of Capital? Of Labor? Does this make any sense?

Chapter 20:

- 1) A producer's production function is  $y = 6K^{1/3}L^{1/2}$ . The market price for the firm's output is  $p$ , the cost of capital is \$4 per unit used and the cost of labor is \$3 per unit.
  - (a) Write an equation for the firm's long-run profit.
  - (b) Find the factor demands for the two inputs.
  - (c) Find an equation for the supply function of the firm and graph it.
  - (d) If the price of the firm's output is  $p=2$ , what are the firm's level of output and profit?
  
- 2) Suppose there is a firm whose production technology is a function of the Social Capital inside the firm. Say the production process can be described by the following production function,  $y = s8K^{1/4}L^{1/2}$  where  $s$  measures the level of trust between workers and managers as in 6).
  - (a) If the firm's capital price is \$8 per unit and the firm's labor price is \$4 per unit, find an equation for the firm's supply function.
  
  - (b) How does Social Capital affect the firm's supply decision? Consider the cases where  $s$  is 0 (i.e. there is no social capital),  $s$  is between 0 and 1 (there is *bad* social capital) and  $s$  is greater than 1 (there is *good* social capital).



Chapter 25:

- 1) *Monopoly Theory* - Say the inverse market demand for a good is  $p(y) = a - 2by$  and all the firms producing in this market have the same cost structure,  $c(y) = c + dy^2$ .
- (a) If there is one firm producing in the market, find the monopolist's profit maximizing output level and price.
- (b) Graph the monopolist's choice on a regular supply and demand graph, including the amount of profit that the monopolist makes.
- (c) If  $a=10$ ,  $b=2$ ,  $c=0$  and  $d=1$ , what is the value of the *deadweight loss* associated with monopoly?

Chapter 28:

- 1) Stackelberg Theory - Now let's say that there are two firms in the market, call them one and two (we are still using the cost functions from (the monopoly problem for Chapter 24)). This means that the inverse market demand is now  $p(y) = a - 2b(y_1 + y_2)$ . If firm one takes on the *leader's* role how much does it produce? How much does the *follower*, firm two, produce? How does this compare to the monopoly situation? Are consumers better or worse off? (Remember that this problem differs from your notes because the firms have costs now. Also, at the end you should plug in the numbers from (1c) to make the algebra easier)
  
- 2) Cournot Theory - Now let's say there is no clear leader (but we are still using  $c(y) = c + dy^2$ ). Find the *best response functions* for two *Cournot duopolists*. What are the production levels of the two Cournot firms. (Remember that this problem differs from your notes because the firms have costs now. Also you should plug in the numbers from (1c) to make the algebra easier)

Chapters 28 and 29:

- (1) **Cournot-Nash 1:** Suppose there are two identical firms that face market demand,  $p=100-(y_1+y_2)$  and the cost structure,  $c(y)=10y_i$  for  $i=1,2$ .
- Set up a normal (or strategic) form game in which the two firms can either produce the Cournot quantity or half the monopoly quantity (the entries should be profits).
  - What is the Nash equilibrium of this normal form game?
- (2) **Cournot-Nash 2:** Suppose that the firms in (1) are no longer completely symmetric. Suppose the cost function for firm two changes to  $c(y)=5y_2$  and firm one is the same.
- Set up a normal (or strategic) form game in which the two firms can either produce the Cournot quantity or half the monopoly quantity (the entries should be profits).
  - What is the Nash equilibrium of this normal form game?
- (3) **Battle of the Sexes:** Henry and Audrey like doing things together; however, there preferences are not identical. Henry prefers ballet while Audrey likes all-star wrestling. The following normal form game represents their preferences.

		Henry	
		Ballet	Wrestling
Audrey	Ballet	3,1	0,0
	Wrestling	0,0	1,3

- Find the *pure* strategy Nash Equilibria.
  - Is there a *mixed* strategy equilibrium?
- (4) **Rock, Paper, Scissors:** Remember “rock smashes scissors,” “paper covers rock,” and “scissors cuts paper.” Imagine the payoff to “winning” is +1 and the payoff to losing is -1. Then the normal form of RPS is just:

		Player 2		
		Rock	Paper	Scissors
Player 1	Rock	0,0	-1,1	1,-1
	Paper	1,-1	0,0	-1,1
	Scissors	-1,1	1,-1	0,0

- Find the *pure* strategy Nash Equilibria.
- Is there a *mixed* strategy equilibrium?

Chapter 18:

- (1) **An Easy Second Price Auction:** Suppose that there are two bidders in a second price auction, that bidder one's value is  $v_1 = \$5$ , that bidder two's value is  $v_2 = \$4$ , and that all bids have to be in multiples of \$2. Draw the normal form and find any Nash equilibria.
- (2) **A Harder Second Price Auction:** Assume that each of "n" bidders has a private value of  $v_i$ ,  $i=1 \dots n$  for the good being auctioned, that each bidder bids  $b_i$ , and that the winner only has to pay  $b_j$  – the second highest bid. Prove that bidding one's value is weakly dominant.
- (3) **A First Price Auction:** Assume that there are 10 people participating in a first price sealed bid auction and that it is common knowledge that private values are distributed independently and uniformly on the  $[0,10]$  interval. Derive the optimal bid,  $b^*$ , of a person whose private value is \$5.