Midterm 2 - Solutions

You have until 4:30pm to complete this exam. Be certain to put your name, id number and section on both the exam and your scantron sheet and fill in test form A on the scantron. Answer all multiple choice questions on your scantron sheet. Choose the single best answer for each question; if you fill in multiple answers for a question you will be marked wrong. Answer the long answer questions directly on the exam. You must show your work for full credit. Answers may be left as fractions. Please place a box around final answers when appropriate. Good luck!

Name: **ID Number:**   **Section:**

SECTION I: MULTIPLE CHOICE (60 points)

1. If a production technology exhibits diminishing marginal product of labor and the 10th worker hired increases output by 20 units:

   (a) The 20th worker hired will increase output by more than 20 units.
   (b) The 20th worker hired will decrease output
   (c) The 5th worker hired will increase output by more than 20 units.
   (d) The 5th worker hired will decrease output.

   (c) Each successive worker will generate a smaller increase in output than the previous worker. So the fifth worker hired will generate a greater increase in output than the 10th worker hired.

2. A market has two consumers. Each consumer has a downward sloping demand curve with a slope of -2. The market demand curve:

   (a) May be upward sloping.
   (b) Will have a slope of -2.
   (c) Will have a slope between 0 and -2.
   (d) Will be steeper than the individual demand curves.

   (c) If both individual demand curves are downward sloping, the market demand curve will also be downward sloping but will be flatter than either individual demand curve. This means it must have a negative slope with a magnitude of less than 2.

3. If the price of x increases, the income and substitution effects for good y will have different signs if:

   (a) y is an inferior good.
   (b) y is a normal good.
   (c) y is a Giffen good.
   (d) They will have the same sign no matter what type of good y is.

(b) If the price of x increases, the substitution effect for y will be positive because y has gotten relatively cheaper. Because of the increase in the price of x effective income will have gone down. If y is a normal good, this will mean a negative substitution effect. If y is an inferior good, it will mean a positive substitution effect.

4. At current prices, the price elasticity of demand for pizza is $-\frac{4}{5}$. Which if the following will happen if the pizza parlor raises its price by a small amount?

   (a) Demand for pizza will increase.
   (b) Revenues will increase.
   (c) Costs will increase.
   (d) Profits will decrease.

   (b) Currently, demand is inelastic meaning that there will be only a small decline in demand when the price is raised. So raising the price will lead to an increase in revenues on the slices still sold that will be larger than the lost revenue from the slices that are no longer purchased.

5. On a graph with labor on the horizontal axis and capital on the vertical axis, the _____, the steeper an isoquant will be.

   (a) The smaller the marginal product of capital.
   (b) The smaller the marginal product of labor.
   (c) The larger the marginal product of capital.
   (d) (b) and (c).

   (a) The magnitude of the slope will be $\frac{MP_L}{MP_K}$. So a larger marginal product of capital or a smaller marginal product of labor will lead to a steeper isoquant.

6. If supply is completely inelastic, then a quantity tax placed on consumers will:

   (a) Increase the equilibrium price paid by consumers but by less than the amount of the tax.
   (b) Decrease the equilibrium price received by producers but by less than the amount of the tax.
   (c) Increase the equilibrium price paid by consumers by the full amount of the tax.
   (d) Decrease the equilibrium price received by producers by the full amount of the tax.

   (d) If supply is inelastic (a vertical supply curve), the entire tax will be passed on to producers.

7. Given an upward sloping linear supply curve and a downward sloping linear demand curve, deadweight loss will _____ as the size of a quantity tax is increased.

   (a) First increase, then decrease.
   (b) First decrease, then increase.
   (c) Steadily increase.
   (d) Steadily decrease.

   (c) Deadweight loss will increase whenever the size of the tax is increased. The tax revenues will increase at first but eventually decrease.

8. If capital is fixed in the short run and labor is variable, increasing the price of capital will
   _____. (Assume that before and after the price change the firm finds it optimal to produce
   a positive quantity of output.):

   (a) Lead the firm to use more labor in the short run.
   (b) Lead the firm to use less labor in the short run.
   (c) Lead the firm to produce less output in the short run.
   (d) None of the above.

   (d) The price of the fixed input will affect a firm's profits in the short run but not
   the optimal level of the variable input or the optimal level of output as long as the
   firm continues to operate.

9. If tacos and salsa are complements, when the price of a taco increases:

   (a) The magnitude of the substitution effect for salsa will be larger than the magnitude of
   the income effect.
   (b) The magnitude of the substitution effect for salsa will be smaller than the magnitude of
   the income effect.
   (c) The sign of the income and substitution effects for salsa will be the same.
   (d) None of the above.

   (b) If tacos and salsa are complements, an increase in the price of tacos will decrease
   demand for salsa. Since salsa has gotten relatively cheaper, the substitution effect
   for salsa will be positive. This means that the income effect must be negative and
   larger in magnitude than the substitution effect (to get a net change in demand
   that is negative).

10. Suppose that widgets are produced with a constant returns to scale technology that uses only
    capital and labor. If a firm is currently earning a profit of $100 using 10 units of capital and
    10 units of labor, then profits when the firm uses 20 units of capital and 20 units of labor will
    be:

    (a) Greater than $200.
    (b) Greater than $100 but less than $200.
    (c) Equal to $200.
    (d) Not enough information.

    (c) Think of the equation for profits: $\pi(2K, 2L) = pf(2K, 2L) - r(2K) - w(2L) =$
    $p2f(K, L) - 2rK - 2wL = 2\pi(K, L)$. Since we are using a constant returns to scale
    technology, doubling inputs will double costs but also double revenues, leading to
    dobule the profits.

11. The cross price elasticity of demand for apples and oranges is -1.6. Which of the following
    can we say for certain:

    (a) Apples and oranges are substitutes.
    (b) Demand for apples in elastic.
    (c) Apples and oranges are complements.
    (d) Demand for oranges is inelastic.

(c) A negative cross price elasticity means that when the price of one good goes up, demand for the other good goes down. This tells us that the two goods are complements.

12. If a quantity tax placed on producers lowers the equilibrium price received by producers and raises and equilibrium price paid by consumers, which of the following is definitely true:

   (a) The loss in consumer surplus will be larger than the loss in producer surplus.
   (b) The loss in consumer surplus will be less than or equal to the loss in producer surplus.
   (c) The loss in consumer and producer surplus will be greater than the tax revenue.
   (d) The loss in consumer and producer surplus will be smaller than the tax revenue.

   (c) If the prices are changing for both the consumers and producers, this means that the tax has changed the equilibrium quantity and generated a deadweight loss. A deadweight loss implies that consumer and producer surplus has fallen by an amount greater than the tax revenue.

13. The isoquants for the production function $f(K, L) = 2K + 3L$ will:

   (a) Be straight lines.
   (b) Be concave.
   (c) Have a dimishing technical rate of substitution.
   (d) Have an increasing technical rate of substitution.

   (a) From the production function, we can see that both the marginal product of capital and the marginal product of labor are constant. This gives us a constant technical rate of substitution which means a constant slope for the isoquants.

14. Suppose we use electricity (E) and typists (T) to produce books. In the short run, electricity is fixed but the number of typists is variable. Which of the following prices would affect the optimal number of typists? (You can assume that we never reach the point where it is optimal to shut down, so the optimal number of typists will be postive.)

   (a) The price of books and the price of electricity.
   (b) The price of electricity and the price of typists
   (c) The price of books and the price of typists.
   (d) The price of books, the price of electricity and the price of typists.

   (c) The price of output and the price of the variable input will affect our short run decision. The price of the fixed input will not.

15. Think about the following sets of goods: hamburgers from McDonald's, hamburgers in general, sandwiches in general (including hamburgers). Which of the following is the most likely ordering of the price elasticity of demand for the different goods, from largest in magnitude to smallest in magnitude:

   (a) McDonald's hamburgers, hamburgers in general, sandwiches in general.
   (b) McDonald's hamburgers, sandwiches in general, hamburgers in general.
   (c) Sandwiches in general, hamburgers in general, McDonald's hamburgers.
   (d) Hamburgers in general, sandwiches in general, McDonald's hamburgers.

(a) The most elastic good will be the one with close substitutes. This would be the McDonald's hamburgers. The least elastic good will be the one with no close substitutes. This would be sandwiches.

16. Suppose we produce output with two inputs, A and B. The production function is $f(A, B) = A^2 + B$. This technology exhibits:

    (a) Constant returns to scale.
    (b) Increasing returns to scale.
    (c) Decreasing returns to scale.
    (d) Not enough information.

    (b) Notice that $f(tA, tB) = t^2 A^2 + tB$. This is greater than $tA^2 + tB$ or $tf(A, B)$. So the technology exhibits increasing returns to scale.

17. If the marginal product of labor is increasing and positive at all levels of labor, a graph of output as a function of labor will:

    (a) Have a positive slope and get steeper as L gets larger.
    (b) Have a negative slope and get flatter as L gets larger.
    (c) Have a positive slope and get flatter as L gets larger.
    (d) Have a negative slope and get steeper as L gets larger.

    (a) It will have a positive slope because the marginal product of labor is positive. It will be getting steeper because the marginal product of labor (equal to the slope of the curve) is getting larger as L gets bigger.

18. If we use only wood and glue to make bookcases and we always have to use them in fixed proportions, then:

    (a) The isoquants will be straight lines.
    (b) The isoquants will be upward sloping.
    (c) The isoquants will be L-shaped.
    (d) The isoquants will be concave.

    (c) For fixed proportions, we get L-shaped isoquants (we can't increase output without increase both inputs). Note that the answer choices were changed at the beginning of the exam.

19. Suppose that we have three consumers in the market for DVDs and all of them have downward sloping, linear demand curves. The market demand curve has a kink at the point (20 DVDs, $10). Which of the following is true?

    (a) There is a consumer who will not pay more than $10 for a DVD.
    (b) None of the consumers will pay more than $10 for a DVD.
    (c) The market demand curve is steeper to the right of the kink than to the left of it.
    (d) There is a consumer who stops buying DVDs when the price drops below $10.

    (a) A kink means that a consumer is entering the market. Since all of the consumers have downward sloping demand curves, this means that when the price drops below $10, there is a consumer who starts buying DVDs. The market demand curve will be steeper to the left of the kink than to the right of the kink.

20. On a graph of output as a function of capital, with capital on the horizontal axis, the slope of the curve is:

   (a) Equal to the marginal product of capital.
   (b) Equal to the marginal product of labor.
   (c) Equal to the technical rate of substitution.
   (d) None of the above.

   (a) The slope is the change in output relative to a change in capital. This is the definition of the marginal product of capital.

SECTION II: SHORT ANSWER (40 points)

For this section, be certain to show your work and clearly label any graphs you draw. Give complete answers but keep them concise. Please place a box around final answers where appropriate.

1. (8 points) There are two consumers, a and b, in the market for coffee (C). There individual inverse demand curves are given by:

$$P(C_a) = 10 - C_a \tag{1}$$

$$P(C_b) = 20 - C_b \tag{2}$$

Graph the market demand curve. Make certain to label all slopes, intercepts and kinks with the appropriate values.

To get the market demand curve, we first have to determine the cutoff prices for each consumer. When C_a is equal to zero, price is 10. When C_b is equal to zero, price is equal to 20. So for prices above \$20, market demand is zero. For prices between \$20 and \$10, market demand is just equal to person b's demand. For prices below \$10, market demand will be equal to the sum of person a's demand and person b's demand:

$$D(p) = 0 \text{ for } p > 20$$

$$D(p) = C_b = 20 - p \text{ for } 10 < p \leq 20$$

$$D(p) = C_a + C_b = 10 - p + 20 - p = 30 - 2p \text{ for } p \leq 10$$

So the graph of the demand curve should hit the y axis at the point (0 cups of coffee, \$20), have a kink at the point (10 cups, \$10), and hit the x axis at the point (30 cups, \$0). The slope of the upper segment will be -1 while the slope of the lower segment will be $-\frac{1}{2}$.
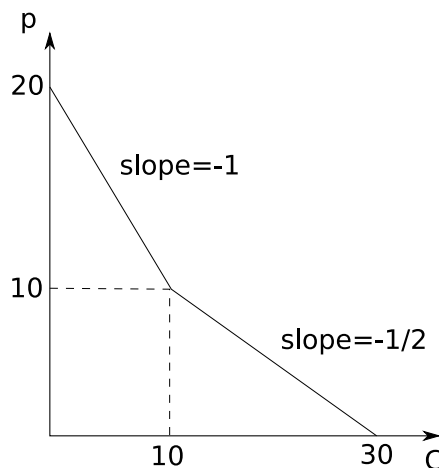
2. (16 points) A car manufacturer uses only capital (K) and labor (L) as inputs and has the following production function:
$$f(K, L) = K^{\frac{1}{2}} L^{\frac{1}{2}} \tag{3}$$

In the short run, capital is fixed at 25 units, the price of a car is $10, the rental rate of capital is $2 and the wage for a worker is $1.

(a) Derive expressions for the marginal product of capital, the marginal product of labor and the technical rate of substitution.

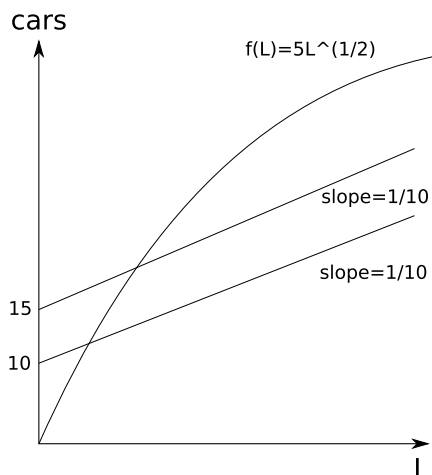$$MP_K = \frac{df(K, L)}{dL} = \frac{1}{2} K^{-\frac{1}{2}} L^{\frac{1}{2}}$$

$$MP_L = \frac{df(K, L)}{dL} = \frac{1}{2} K^{\frac{1}{2}} L^{-\frac{1}{2}}$$

$$TRS = -\frac{MP_L}{MP_K} = -\frac{\frac{1}{2} K^{\frac{1}{2}} L^{-\frac{1}{2}}}{\frac{1}{2} K^{-\frac{1}{2}} L^{\frac{1}{2}}} = -\frac{K}{L}$$

(b) On a graph with labor on the horizontal axis and cars on the vertical axis, sketch cars as a function of labor in the short run. Include the equation for the curve on the graph.

In the short run, capital is fixed at 25 units. So output as a function of labor is:

$$y(L) = f(25, L) = (25)^{\frac{1}{2}} L^{\frac{1}{2}} = 5L^{\frac{1}{2}}$$

(c) On the same graph, sketch two isoprofit lines, one for a profit level of $50 and one for a profit level of $100. Be certain to clearly label the slopes and intercepts of these isoprofit lines with their actual values.

To get the equation for the isoprofit line, start from the profit equation:

$$\pi = py - rK - wL$$

$$y = \frac{\pi}{p} + \frac{r}{p} K + \frac{w}{p} L$$

$$y = \frac{\pi}{10} + \frac{2}{10}25 + \frac{1}{10}L$$

$$y = \frac{\pi}{10} + 5 + \frac{1}{10}L$$

So the isoprofit lines will have a slope of $\frac{1}{10}$ and an intercept equal to $\frac{\pi}{10} + 5$. For profits of \$50, the intercept will be 10 and for profits of \$100, the intercept will be 15.

(d) Find the optimal level of labor in the short run.

The optimal level of labor will be the level at which the wage is equal to the value of the marginal product of labor:

$$w = pMP_L(\bar{K}, L)$$

$$w = p\frac{1}{2}\bar{K}^{\frac{1}{2}}L^{-\frac{1}{2}}$$

$$1 = 10\frac{1}{2}(25)^{\frac{1}{2}}L^{-\frac{1}{2}}$$

$$L^{\frac{1}{2}} = 25$$

$$L = 625$$

3. (16 points) The market for newspapers (N) has the following market demand and market supply functions:

$$D(p_N) = 100 - p_N \tag{4}$$

$$S(p_N) = p_N \tag{5}$$

(a) Find the equilibrium price and quantity of newspapers.

To find the equilibrium price, we can set the demand equation equal to the supply equation:

$$D(p_N) = S(p_N)$$
$$100 - p_N = p_N$$
$$100 = 2p_N$$
$$p_N = 50$$

Plugging this equilibrium price of $50 into either the demand or the supply equation will give us an equilibrium quantity of 50 newspapers.

(b) A tax of $10 is placed on consumers. Find the new equilibrium quantity of newspapers, price paid by consumers and price received by producers.

To find the new equilibrium price received by producers we can set the demand for a price of $p_N + 10$ equal to the supply for a price of p_N:

$$D(p_N + 10) = S(p_N)$$
$$100 - p_N - 10 = p_N$$
$$90 = 2p_N$$
$$45 = p_N$$

So the producers receive a price of $45. At this price, they would sell 45 newspapers. The buyers pay this price plus the tax, making the price paid $55. If we plug $55 into the demand equation, we see that we get the same quantity of 45 newspapers. Notice that in this case, the tax burden is split evenly between the producers and the consumers.

(c) Calculate the tax revenue generated by the tax and the deadweight loss created by the tax.

Tax revenue is just the number of newspapers sold times the tax per newspaper:

$$taxrev = t \cdot q = \$10 \cdot 45 = \$450$$

The deadweight loss is equal to the consumer surplus and producer surplus lost on the 5 units that are no longer being sold. This is the area under the demand curve and above the supply curve between the quantity of 45 and the quantity of 50. This area is:

$$DWL = \frac{1}{2}(55 - 45)(50 - 45) = 25$$

(d) If demand were given by $D(p_N) = 150 - p_N$ would the tax revenue be larger, smaller or the same as what you found in part (c)? Would the deadweight loss be larger, smaller or the same as what you found in part (c)? (You can use either calculations or a graph to justify your answer.)

If you calculate the pre-tax and post-tax equilibrium prices and quantities, you will find that the tax lowered the quantity sold from 75 to 70, raised the consumers price from 75 to 80 and lowered the producers price from 75 to 70. The deadweight loss will be the same as before (the dimensions of the deadweight loss triangle are identical to what they were in the previous part). However, the tax revenue will be much larger ($700) because of the larger quantity being sold. Shifting around the supply curve or the demand curve will tend to change tax revenue but not deadweight loss as long as the size of the tax is being held constant. What will change deadweight loss is if we change the slope of either the supply or demand curve.