
Final Exam - Solutions

You have until 5:30pm 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 where relevant for full credit. Good luck!

Name:

ID Number:

Section:

SECTION I: MULTIPLE CHOICE (60 points)

1. Suppose that a firm in a competitive industry is currently producing at a quantity where price equals marginal cost and the marginal cost curve has a negative slope. Which of the following is definitely true?
 - (a) The firm is maximizing profits.
 - (b) The firm could increase profits by shutting down.
 - (c) The firm could increase profits by increasing output.
 - (d) None of the above.

(c) At the current quantity, price equal marginal cost. Since the marginal cost curve is downward sloping, the marginal cost of the next unit will be below the price. This means that the firm will earn positive profits on the next unit, increasing overall profits.
2. Suppose that a consumer is currently at a bundle that is not on her budget line. We can say for certain that she is not maximizing utility if:
 - (a) The marginal utilities of both goods are negative.
 - (b) The marginal utilities of both goods are positive.
 - (c) Both (a) and (b).
 - (d) Neither (a) nor (b).

(b) If the marginal utilities of both goods are positive, spending additional money on either good will increase utility. So the consumer could get more utility by spending her unused income. If the marginal utilities were negative, spending more on either good would lower utility.
3. On a graph with capital on the horizontal axis and output on the vertical axis, which of the following would make the isoprofit lines steeper?
 - (a) An increase in the wage.
 - (b) An increase in the price of output.
 - (c) An increase in the rental rate of capital.

- (d) None of the above.
- (c) The slope of the isoprofit lines would be equal to the rental rate of capital divided by the price of output. Increasing the rental rate of capital or decreasing the price of output would make the isoprofit lines steeper. Increasing the wage would have no effect on the slope of the isoprofit lines.
4. The demand curve for pineapples is downward sloping and the supply curve for pineapples is upward sloping. A \$2 quantity tax placed on consumers will:
- (a) Generate the same deadweight loss as a \$2 quantity tax placed on producers.
 - (b) Generate the same tax revenue as a \$2 quantity tax placed on producers.
 - (c) Both (a) and (b) are true.
 - (d) Neither (a) nor (b) is definitely true.
- (c) The effects of the tax will be the same whether the tax is placed on consumers or producers. Either way, the tax will generate the same change in prices and quantity and generate the same tax revenue and deadweight loss.
5. Suppose that the marginal utility of bananas is positive and increasing. Adam is currently consuming ten bananas and the price of a banana is 50 cents. The next dollar Adam spends on bananas will:
- (a) Increase Adam's utility by the same amount as the previous dollar he spent on bananas.
 - (b) Increase Adam's utility but by less than the previous dollar he spent on bananas.
 - (c) Increase Adam's utility by more than the previous dollar he spent on bananas.
 - (d) Decrease Adam's utility.
- (c) The next dollar spent on bananas will buy two more bananas just like the previous dollar did. However, since marginal utility is increasing, the utility Adam gets from these two additional bananas will be greater than the utility he got from the previous two bananas.
6. A firm uses inputs A and B to produce output. Neither input is fixed. The firm is currently using a combination of A and B at which the current isoquant is steeper than the current isocost line on a graph with A on the horizontal axis and B on the vertical axis. The firm could increase output while keeping costs the same by:
- (a) Moving down and right along the isoquant.
 - (b) Moving up and left along the isoquant.
 - (c) Moving down and right along the isocost line.
 - (d) Moving up and left along the isocost line.
- (c) Moving along the isocost line will keep total costs the same. Since the isoquant is steeper than the isocost line, moving down and right along the isocost line will move the firm above the current isoquant, meaning they will increase output.
7. There are two consumers for DVDs, Betsy and Calvin. Both have downward sloping demand curves. Betsy stops buying DVDs when the price gets above \$10. Calvin stops buying DVDs when the price gets above \$8. Which of the following is definitely true?

- (a) The demand curve will have a kink at \$8 and be flatter to the left of the kink than to the right of the kink.
 - (b) The demand curve will have a vertical intercept at \$10.
 - (c) The demand curve will be upward sloping.
 - (d) None of the above.
- (b) There will be zero demand at prices above \$10 and positive demand for prices below \$10, so the vertical intercept of the demand curve will be at \$10. There will be a kink in the demand curve at \$8 when Calvin starts buying DVDs. The market demand curve will be flatter to the right of the kink than to the left of the kink.
8. If a firm has no fixed costs we can say for certain that:
- (a) The firm's marginal cost curve will be a horizontal line.
 - (b) The firm's shutdown price will be the same as its breakeven price.
 - (c) The firm will produce at all positive prices.
 - (d) The firm's marginal cost curve will be above its average cost curve.
- (b) The firm's shutdown price is at the minimum of the average variable cost curve. The breakeven price is at the minimum of the average total cost curve. If there are no fixed costs, these are the same curve.
9. A firm's only input is labor. If the firm's production function exhibits increasing returns to scale:
- (a) The marginal product of labor must be decreasing.
 - (b) The marginal product of labor must be increasing.
 - (c) The marginal product of labor must be constant.
 - (d) None of the above.
- (b) If labor is the only input, then increasing returns to scale means that doubling labor will more than double output. So the second worker will produce more than the first worker, the second ten workers will produce more than the first ten workers, and so on. This is only possible if the marginal product of labor is increasing.
10. If Donald has upward sloping indifference curves:
- (a) His preferences are not monotonic.
 - (b) His preferences are not transitive.
 - (c) He is not maximizing his utility.
 - (d) He will not spend his entire income if he is maximizing utility.
- (a) If his indifference curves are upward sloping, it means that there are certain bundles for which increasing both goods does not increase utility. There will also be bundles with more of both goods that are actually on a lower indifference curve. This violates monotonicity.
11. A firm should shut down in the short run if:
- (a) Variable costs are greater than fixed costs.
 - (b) Variable costs are greater than total revenue.
 - (c) Total costs are greater than fixed costs.

- (d) Fixed costs are greater than total revenue.
- (b) If variable costs are greater than total revenue, then the firm will be earning negative profits equal to its fixed costs plus the portion of variable costs that is not covered by its revenues. The firm would be better off just shutting down and only losing its fixed costs.
12. If gasoline is an ordinary good, we can say for certain that:
- (a) The demand curve for gasoline will be downward sloping.
(b) The Engel curve for gasoline will be upward sloping.
(c) Both (a) and (b).
(d) Neither (a) nor (b).
- (a) If gasoline is ordinary, it means that demand increases when price decreases implying that the demand curve is downward sloping. Knowing that gasoline is ordinary does not tell us whether it is inferior or normal, so we do not know whether the Engel curve is downward or upward sloping.
13. If the income elasticity of demand for bread is positive, we could conclude that:
- (a) Bread is an inferior good.
(b) Bread is a Giffen good.
(c) Bread is a normal good.
(d) Not enough information.
- (c) A positive income elasticity means that an increase in income leads to an increase in demand. This is the definition of a normal good.
14. Suppose that in the short run, some of a restaurant's ingredients are fixed inputs. Other ingredients and the kitchen staff are variable inputs. The costs of producing one hundred meals in the short run will definitely be:
- (a) Less than the costs of producing one hundred meals in the long run.
(b) Greater than the costs of producing one hundred meals in the long run.
(c) Less than the costs of producing two hundred meals in the long run.
(d) None of the above are definitely true.
- (d) The short run costs of producing one hundred meals will be greater than or equal to the long run costs of producing one hundred meals. We do not have enough information to say how the short run costs of one hundred meals would compare to the long run costs of producing two hundred meals.
15. If pancakes and waffles are perfect substitutes, the marginal rate of substitution of pancakes for waffles will be:
- (a) Diminishing.
(b) Increasing.
(c) Constant.
(d) Not enough information.
- (c) By definition, a person is always willing to trade between perfect substitutes at a constant rate. This rate is the marginal rate of substitution.

16. If capital is the only variable input in the short run, a profit-maximizing firm will choose the level of capital at which:
- (a) The price of output is equal to the price of a unit of capital.
 - (b) The price of a unit of capital is equal to the marginal product of a unit of capital.
 - (c) The price of a unit of capital is equal to the revenue generated by the last unit of capital.
 - (d) The price of a unit of output is equal to the revenue generated by the last unit of capital.
- (c) The firm will use capital up to the point where the last unit of capital generates just enough revenue to cover its cost.
17. We would expect the price elasticity of demand for a necessity like medicine to be:
- (a) Larger in magnitude than the price elasticity of demand for a good with many close substitutes.
 - (b) Smaller in magnitude than the price elasticity of demand for a good with many close substitutes.
 - (c) Large and positive.
 - (d) Perfectly elastic.
- (b) Demand for a necessity will tend to be very inelastic. The quantity of a necessity like medicine will not vary much with a change in price.
18. A competitive firm is currently producing at a positive quantity where marginal cost is below average cost. Assuming the firm is behaving optimally, which of the following must be true?
- (a) The firm is earning positive profits.
 - (b) The firm has no fixed costs.
 - (c) The firm's average cost curve is downward sloping at the current quantity.
 - (d) The firm's average variable cost curve is downward sloping at the current quantity.
- (c) If marginal costs are below average costs, the cost of the next unit will be less than the previous average, pulling down the average. Therefore the average cost curve will be downward sloping.
19. Suppose that a firm's only two inputs are capital and labor. If the firm uses ten units of capital and no labor, it can produce 100 units of output. It can also produce 100 units of output using no capital and ten units of labor. If the firm can only produce 80 units of output when using five units of capital and five units of labor:
- (a) The firm's production technology exhibits decreasing returns to scale.
 - (b) The firm's production technology exhibits increasing returns to scale.
 - (c) The firm's production technology is not monotonic.
 - (d) The firm's production technology is not convex.
- (d) Note that (10 capital, 0 labor) produces the same quantity as (0 capital, 10 labor). The average of these two combinations of inputs, five units of capital and five units of labor, produces less output. This means that the production technology is not convex.
20. Which of the following would definitely not shift a consumer's demand curve for asparagus?

- (a) A change in preferences.
- (b) A change in income.
- (c) A change in price of asparagus.
- (d) A change in the price of lemons.

(c) A change in the price of asparagus would be a movement along the demand curve, not a shift in the demand curve.

SECTION II: SHORT ANSWER (40 points)

1. (15 points) The only costs for a clothing manufacturer are what it spends on fabric and workers. For every shirt the clothing manufacturer wants to make, it must use two units of fabric and one worker. So if it wanted to make ten shirts it would need to use twenty units of fabric and ten workers. The price of a unit of fabric is \$5 and the price of a worker is \$10.

- (a) Write down a production function for the manufacturer that gives the number of shirts produced (S) as a function of the amount of fabric (F) and number of workers (W) used.

Notice that this is a fixed proportions technology, the firm must always combine fabric and workers in a two to one ratio. It's output will be limited by whichever input it does not have enough of. The function that describes this sort of technology will be a *min* function of the form:

$$S = \min(aF, bW)$$

To determine what the coefficients must be, just think of how much output each unit of input makes. It takes two units of fabric to make one shirt. So the number of shirts we make can be no greater than one half the number of units of fabric used. It takes one worker to make one shirt. So the number of shirts produced can be no greater than the number of workers used. This tells us that the coefficient in front of F should be $\frac{1}{2}$ and the coefficient in front of W should be one:

$$S = \min\left(\frac{1}{2}F, W\right)$$

- (b) Write down a function that gives costs as a function of the number of shirts produced. Assume that the manufacturer chooses its inputs to minimize total costs.

Notice that we can't use our usual tangency condition here since we cannot take derivatives of the production function to find the marginal product of each input. However, it is easy to see what the firm should do to minimize costs. The firm shouldn't have any excess fabric or workers. If $\frac{1}{2}F$ is greater than W , then the extra fabric costs money but doesn't provide any additional output. Similarly, if W is greater than $\frac{1}{2}F$, there are extra workers that cost money but produce no additional output. So the firm will only be minimizing costs if:

$$\frac{1}{2}F = W$$

To get costs as a function of output, we need to get F and W as functions of output. We can do this by plugging the above result into the production function:

$$\begin{aligned} S &= \min\left(\frac{1}{2}F, W\right) \\ S &= \min\left(\frac{1}{2}F, \frac{1}{2}F\right) \\ S &= \frac{1}{2}F \end{aligned}$$

$$F = 2S$$
$$W = \frac{1}{2}F = \frac{1}{2}2S = S$$

Now we have everything we need to write costs as a function of output:

$$C(S) = p_F F(S) + p_W W(S)$$

$$C(S) = 5F(S) + 10W(S)$$

$$C(S) = 5 \cdot 2S + 10 \cdot S$$

$$C(S) = 20S$$

- (c) Suppose that the clothing industry is competitive. What will the market price of a shirt be in the long run?

If the industry is competitive, the long run price will be the breakeven price for an individual firm. This occurs at the minimum of the average cost curve. To find this point, we first need to derive the average cost curve based on the cost function we found in the previous part:

$$AC(S) = \frac{C(S)}{S}$$

$$AC(S) = 20$$

So in this case, average costs are constant and equal to \$20. If the price is above \$20, firms will earn positive profits. If the price is below \$20, firms would shut down. At a price of \$20, firms will earn zero profits and the industry will be in its long run equilibrium.

2. (15 points) A firm can use two different factories to produce output, factory A and factory B . The cost functions for each factory in terms of the output produced at the factory are:

$$C_A(y_A) = 10y_A^2 \quad (1)$$

$$C_B(y_B) = 20y_B^2 \quad (2)$$

- (a) Suppose that the firm wants to produce 90 units of output. How much output would the firm produce at factory A and how much output would it produce at factory B if it wanted to minimize total costs?

The firm will split output between factories so that the marginal costs are the same at both factories. If the marginal costs differed, it would be possible to save money by shifting output from the high marginal cost factory to the low marginal cost factory. Setting the marginal costs at the two factories equal to each other gives us:

$$MC_A(y_A) = MC_B(y_B)$$

$$20y_A = 40y_B$$

$$y_A = 2y_B$$

So the firm will produce twice as much output in factory A as in factory B . To find y_A and y_B in terms of total output, we can just use the fact that y_A and y_B should add up to the total output:

$$y = y_A + y_B$$

$$y = 2y_B + y_B$$

$$y_B = \frac{1}{3}y$$

$$y_A = 2y_B = \frac{2}{3}y$$

Plugging 90 into these equations for y gives us 60 units of output at factory A and 30 units of output at factory B .

- (b) Derive a cost function for the firm that gives costs as a function of total output ($C(y)$). Assume that the firm minimizes costs.

Total costs will just be the costs at factory A plus the costs at factory B :

$$C(y) = C_A(y_A) + C_B(y_B)$$

$$C(y) = 10y_A^2 + 20y_B^2$$

Now we can plug in our results for y_A and y_B in terms of y :

$$C(y) = 10 \left(\frac{2}{3}y \right)^2 + 20 \left(\frac{1}{3}y \right)^2$$

$$C(y) = 10 \cdot \frac{4}{9}y^2 + 20 \cdot \frac{1}{9}y^2$$

$$C(y) = \frac{60}{9}y^2$$

$$C(y) = \frac{20}{3}y^2$$

- (c) Suppose that the firm renovates factory A and as a result, the new cost function for factory A is:

$$C_A(y_A) = 10y_A^{\frac{1}{2}} \quad (3)$$

The cost function for factory B has not changed. Given this new cost function for factory A , find the firm's new total cost function ($C(y)$) for producing any quantity greater than or equal to one (still assuming that the firm minimizes costs). (Note that during the exam it was added that the firm cannot produce a fraction of a unit at a factory, so output at a factory is either zero or greater than or equal to one).

We could try setting marginal costs at the two factories equal to each other once again. However, we will run into a problem. To see what that problem is, let's take a look at the two marginal cost functions:

$$MC_A(y_A) = 5y_A^{-\frac{1}{2}}$$

$$MC_B(y_B) = 40y_B$$

Notice that the marginal costs at factory A are decreasing as output increases while the marginal costs at factory B are increasing as output increases. Another thing to notice is that by the first unit of output, the marginal costs at factory A are already lower than the marginal costs at factory B :

$$MC_A(1) = 5 \cdot 1^{-\frac{1}{2}} = 5$$

$$MC_B(1) = 40 \cdot 1 = 40$$

So marginal costs of the first unit are higher at B than at A . So the firm would decide to produce its first unit at factory A . However, once that first unit is produced at factory A , the marginal costs at factory A get even lower for the next unit while the marginal costs at factory B haven't changed (since y_B hasn't changed yet). So the firm will also want to produce this next unit at factory A . This will continue for each additional unit of output. Since marginal costs are decreasing at factory A , each additional unit will continue to cost less to produce at factory A than it would cost to produce it as the first unit at factory B . The firm will want to produce every unit of output at factory A . This tells us the following:

$$y_A = y$$

$$y_B = 0$$

$$C(y) = C_A(y_A) + C_B(y_B)$$

$$C(y) = 10y_A^{\frac{1}{2}} + 20y_B^2$$

$$C(y) = 10y^{\frac{1}{2}} + 20 \cdot 0^2$$

$$C(y) = 10y^{\frac{1}{2}}$$

3. (10 points) Suppose that the market for cigarettes is competitive and firms can freely enter and exit in the long run. The state government decides to impose a \$2 per pack tax on cigarettes. On a graph with packs of cigarettes on the horizontal axis and the price of a pack of cigarettes on the vertical axis, show the effect this cigarette tax will have on consumer surplus in the long run. Assume that the demand curve is linear and downward sloping. Also assume that before the tax is put in place, the cigarette market was in a long run equilibrium with a market price of \$5 a pack and a total quantity of 1000 packs sold. Be certain to show all of the following on your graph:

- The demand curve.
- The long run supply curve (you do not need to show any short run supply curves).
- The pre-tax equilibrium.
- The long run equilibrium after the tax, labelling price and quantity with exact numbers if possible.
- The change in consumer surplus.

The graph is shown below. Note the following important features. Since the market is competitive, the long run supply curve will be a horizontal line at the breakeven price. We know that the market was initially in a long run equilibrium at a price of \$5, so this horizontal line should be at \$5. The original demand curve should be a downward sloping line that intersects the long run supply curve at the point (\$5,1000 packs). This point is the original equilibrium. The effect of the tax is to shift the demand curve down by \$2. Where this shifted demand curve intersects the supply curve will be the new long run equilibrium quantity, q^* . The new equilibrium price for suppliers is still \$5. The new equilibrium price for consumers is found by looking at the original demand curve at the new equilibrium quantity of q^* . This will give us a new equilibrium price paid by consumers of \$7 (the price received by producers plus the \$2 tax). The change in consumer surplus is the area under the demand curve between the new price of \$7 and the old price of \$5 up to the original quantity of 1000 packs. This is the shaded area on the graph.

