ECON 173 - Intermediate Microeconomic Analysis
Drake University, Fall 2019
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Signature: _____

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EXAMINATION #1 VERSION A
"Mathematical Tools"
September 3, 2019

INSTRUCTIONS: This exam is closed-book, closed-notes. Calculators, mobile phones, and wireless devices are NOT permitted. Point values for each question are noted in brackets.

I. MULTIPLE CHOICE: Circle the one best answer to each question. Use margins for scratch work. [2 pts each—30 pts total]

(1) Suppose the derivative of the function $y = f(x)$ equals 3 at a particular value of x. At that point, the graph of the function is
a. vertical.
b. horizontal.
c. upward-sloping.
d. downward-sloping.
e. cannot be determined from the information given.

(2) Suppose $y = 5 + (7/x)$. Then the derivative of y with respect to x is given by the formula
a. $dy/dx = 7$.
b. $dy/dx = 7/x^2$.
c. $dy/dx = -7/x^2$.
d. $dy/dx = 12x$.
e. none of the above.

(3) Suppose $y = 5x^2 + 2x + 7$. Then the derivative of y with respect to x is
a. $dy/dx = 10$.
b. $dy/dx = 5$.
c. $dy/dx = 5x + 2$.
d. $dy/dx = 10x + 2$.
e. $dy/dx = 5x + 7$.
f. $dy/dx = 5x^2 + 2x + 7$.

(4) Suppose $y = (4x-5)^3$. Then the derivative of y with respect to x is given by
a. $dy/dx = 3$.
b. $dy/dx = 4$.
c. $dy/dx = 12x$.
d. $dy/dx = 3(4x-5)^2$.
e. $dy/dx = 12(4x-5)^2$.

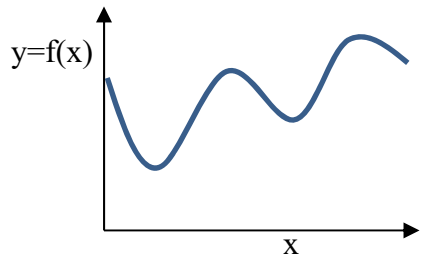
(5) Suppose $y = x^{1/2}$. Then the derivative of y with respect to x is given by
a. $dy/dx = x/2$.
b. $dy/dx = (1/2)\, x^{1/2}$.
c. $dy/dx = (1/2)\, x^{-1/2}$.
d. $dy/dx = (-1/2)\, x^{-1/2}$.
e. none of the above.

(6) Suppose $y = 2\,(5+4x)^3$. Then the derivative of y with respect to x is
a. $dy/dx = 10$.
b. $dy/dx = 40$.
c. $dy/dx = (5+4x)^2$.
d. $dy/dx = 6\,(5+4x)^2$.
e. $dy/dx = 24\,(5+4x)^2$.

(7) Which of the following functions has constant slope (or derivative)?
a. $y = 7 + 3x$.
b. $y = 7 + (5/x)$.
c. $y = \ln(3x)$.
d. $y = \exp(2x)$.
e. $y = 7 + 5x + (2/3)x^3$.
f. $y = 7x^{-3}$.

(8) If x increases by 3 percent, then ln(x) increases by about
a. ln(3), or about 1.099 units.
b. 0.03 percent.
c. 0.03 units.
d. 3 percent.
e. 3 units.

The next question refers to the following graph of $y = f(x)$.



(9) In this graph, the derivative of y with respect to x (that is, df/dx) equals zero at
a. no point on the graph.
b. one point on the graph.
c. two points on the graph.
d. three points on the graph.
e. four points on the graph.
f. more than four points on the graph.

(10) Suppose we wish to minimize the function $y = f(x)$, which is continuously differentiable. Assuming there are no restrictions on the possible values of x, the minimizing value x* must satisfy
a. $df/dx = 0$, if $x = x^*$.
b. $d^2f/dx^2 = 0$, if $x = x^*$.
c. $x^* = 0$.
d. $f(x^*) = 0$.
e. All of the above.

(11) If y is inversely proportional to x (that is, if $y = c/x$, where c is an unknown constant) then the elasticity of y with respect to x equals
a. c.
b. zero.
c. one-half.
d. one.
e. minus one.
f. cannot be determined from information given.

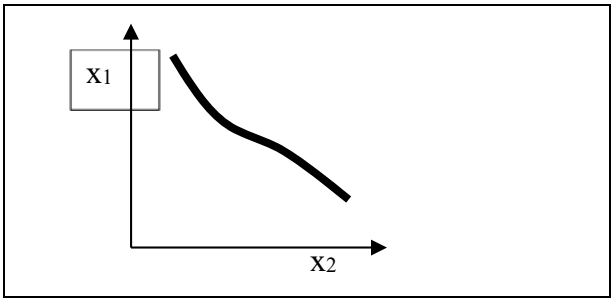
(12) Consider the following functions. Which has constant elasticity?
a. $y = 7 + 3x$.
b. $y = 7 + (5/x)$.
c. $y = \ln(3x)$.
d. $y = \exp(2x)$.
e. $y = 7 + 5x + (2/3)x^3$.
f. $y = 7x^{-3}$.

(13) A straight line does *not* have constant
a. slope.
b. elasticity.
c. It has neither constant slope nor constant elasticity.
d. It has both constant slope and constant elasticity.

(14) Suppose y denotes the quantity demanded of gasoline (in gallons) and x denotes the price of gasoline (in U.S. dollars). Consider the demand function $y = f(x)$. The units of measure for the *derivative* of y with respect to x are

a. gallons.
b. dollars.
c. gallons per dollar.
d. The derivative is unit-free.

The next question refers to the following graph of a level curve, or contour, of the function $y = f(x_1,x_2)$.



(15) As we move along this curve down and to the right, what remains unchanged?

a. y.
b. x_1 .
c. x_2 .
d. both x_1, and x_2 .
e. the marginal rate of substitution.
f. All of the above remain unchanged.

II. SHORT ANSWER: Please write your answers in the boxes on this question sheet. Use margins for scratch work.

(1) [4 pts] Suppose the derivative of the function $y = f(x)$ equals -2 at a particular value of x. Moreover, the elasticity of y with respect to x equals -0.5 . Further suppose that x increases by 4 *percent*. [Hint: Some of this information is extraneous and not needed to answer this question.]

a. Will y *increase* or *decrease*?

b. By about how much?

percent

(2) [4 pts] Consider the function $y = f(x_1,x_2)$. Suppose at a particular point, $\partial y/\partial x_1 = 0.2$, and $\partial y/\partial x_2 = 0.6$, and that the partial elasticities are $\varepsilon_1 = 0.5$ and $\varepsilon_2 = 1.2$. Further suppose that x_1 increases by 2 *units* and simultaneously x_2 increases by 5 *units*. [Hint: Some of this information is extraneous and not needed to answer this question.]

a. Will y *increase* or *decrease*?

b. By about how much?

units

(3) [4 pts] Total revenue equals price times quantity. Suppose price increases by 4 percent and output quantity decreases by 1 percent.

a. Will total revenue *increase* or *decrease*?

b. By about how much? percent

(4) [4 pts] Unit cost equals total cost divided by output quantity. Suppose output quantity increases by 3 percent and total cost increases by 5 percent.

a. Will unit cost *increase* or *decrease*?

b. By about how much? percent

(5) [8 pts] Consider the function $y = f(x_1,x_2)$. Suppose at a particular point, $\partial y/\partial x_1 = 3$, and $\partial y/\partial x_2 = 2$. First, suppose that x_1 increases by 10 units but x_2 does not change.

a. Will y *increase* or *decrease*?

b. By about how much? units

Now suppose that x_1 increases by 10 units but we want y to remain constant. To keep y constant, we must change the value of x_2.

c. Must x_2 *increase* or *decrease*?

d. By about how much? units

(6) [4 pts] Consider the function $y = f(x_1,x_2)$. Suppose at a particular point, $\partial y/\partial x_1 = 2$, and $\partial y/\partial x_2 = 5$. Now consider a graph of the level curve of this function, with x_1 on the vertical axis and x_2 on the horizontal axis.

a. Does the level curve of the function slope *up* or *down* at that point?

b. Give the slope of the level curve at this point.

III. PROBLEMS: Please write your answers in the boxes on this question sheet. Show your work and circle your final answers.

(1) [Optimization: 8 pts] Consider the function $y = f(x) = -2x^2 + 20x + 3$.

a. Find an expression (in terms of x) for the derivative of y with respect to x (dy/dx).

b. Compute the value x* that maximizes this function.

c. For what range of values of x does this function slope up? For what range of values does it slope down?

d. Find the maximum value, y*, of the function itself.

(2) [Partial elasticities: 6 pts] Suppose $y = (x_1 - 3)^2 x_2^4$.

a. Find an expression for ε_1, the partial elasticity of y with respect to x_1. The variable y should *not* appear in your answer.

b. Find an expression for ε_2, the partial elasticity of y with respect to x_2. The variable y should *not* appear in your answer.

(3) [MRS: 12 pts] Suppose $y = f(x_1,x_2) = (x_1 - 2)^3 (x_2 + 4)^5$. The arguments x_1 and x_2 are strictly positive.

a. Find an expression for the partial derivative of y with respect to x_1 .

b. Find an expression for the partial derivative of y with respect to x_2 .

c. Find an expression for the marginal rate of substitution of x_2 for x_1 (that is, the formula for the |slope| of the level curves of y, with x_1 on the vertical axis and x_2 on the horizontal axis). Simplify if possible.

(4) [MRS: 12 pts] Suppose $y = f(x_1,x_2) = -2\,x_1^{-1} - 3\,x_2^{-1}$. The arguments x_1 and x_2 are strictly positive.

a. Find an expression for the partial derivative of y with respect to x_1 .

b. Find an expression for the partial derivative of y with respect to x_2 .

c. Find an expression for the marginal rate of substitution of x_2 for x_1 (that is, the formula for the |slope| of the level curves of y, with x_1 on the vertical axis and x_2 on the horizontal axis). Simplify if possible.

IV. CRITICAL THINKING: [4 pts] Answer *one* question below (your choice). Circle the question you are answering. Justify your answer and show your work.

(1) Suppose x denotes a firm's output, which cannot be negative, and y denote's the firm's profit, which can be positive or negative. What non-negative value of x maximizes the profit function $y = f(x) = -3x^2 - 2x - 5$? What value of y does it yield? Justify your answer. Sketch the graph of $y = f(x)$. Label the axes.

(2) Suppose $U = f(I,P)$, where U = utility or well-being, P = pollution, and I = income, where P and I are strictly positive. Further suppose $\partial U/\partial I$ is positive, but $\partial U/\partial P$ is negative. Do the level curves of $f(I,P)$ slope *up* or *down*? Justify your answer. Sketch a typical level curve. Label the axes.

[end of exam]