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## Midterm 2

You have until 1:50pm to complete the exam, be certain to use your time wisely. Answer all questions directly on the exam. You must show all of your work to receive full credit. Calculators may be used although you may leave answers as fractions. Unless a problem says otherwise, you can assume that firms can use fractions of units of inputs, produce fractions of units of output and charge non-integer prices (so a firm could use 28.6 units of input to produce 82.4 units and sell at a price of \$5.325 per unit). Remember to put your name on the exam. Good luck!

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**Name:**

**ID Number:**

1. (20 points) For each of the scenarios below, write down a production function that matches the description of the firm's production technology.
  - (a) A baker uses eggs ( $E$ ), flour ( $F$ ) and water ( $W$ ) to produce loaves of bread ( $L$ ). One loaf of bread requires exactly two eggs, four cups of flour and two cups of water. The baker cannot produce partial loaves of bread (it only has one size of loaf pan).
  - (b) A tax preparation service uses accountants ( $A$ ) and computers ( $C$ ) to complete tax returns ( $R$ ). Every extra computer used by the service increases the number of completed tax returns by the same amount as the previous computer. Every extra accountant increases the number of tax returns filed but by a smaller amount than the previous accountant did. Each accountant is more productive if there are more computers.
  - (c) Everything is the same as in part (b) except that each accountant's productivity does not depend on the number of computers used by the service.
  - (d) A textbook publisher uses printing presses ( $P$ ) and computers ( $C$ ) to produce textbooks ( $T$ ). The marginal product of printing presses is diminishing and the marginal product of computers is also diminishing. However, the textbook publisher's technology exhibits increasing returns to scale. If the publisher uses eight printing presses and one computer, it can publish 400 textbooks.

2. (25 points) There are two types of firms that produce yoga mats, type  $A$  and type  $B$ . The cost functions for a firm of each type are given by:

$$C_A(y) = 10y + 10y^2 \quad (1)$$

$$C_B(y) = 5y + 10y^2 \quad (2)$$

where  $y$  is the number of yoga mats produced by the firm. There are currently 30 type  $A$  firms in the industry and 20 type  $B$  firms in the industry. The industry is perfectly competitive and there is free entry and exit of firms in the long run.

- Find expressions for average total costs ( $AC(y)$ ), average variable costs ( $AVC(y)$ ) and marginal costs ( $MC(y)$ ) for each firm type.
- Find the supply equation ( $S(p)$ ) for each firm type. Be certain to be explicit about the range of prices over which each firm type will produce.
- Graph the short run industry supply curve and the long run industry supply curve. Label all slopes, intercepts and kinks with their numerical values.
- How would you expect your supply curves in part (c) to change if the prices of inputs for yoga mats fell? Be certain to fully explain your answer.

3. (30 points) A farmer uses soil ( $S$ ) and fertilizer ( $F$ ) to grow zucchini ( $Z$ ). The amount of zucchini the farmer can grow is given by the following production function:

$$Z = 10S + 4F^{\frac{1}{2}} \quad (3)$$

The price of a unit of soil is \$5. The price of a unit of fertilizer is \$2. The market price for a unit of zucchini is \$10.

- (a) Find expressions for the marginal product of soil, the marginal product of fertilizer and the technical rate of substitution. Your expression for the technical rate of substitution should correspond to the slope of an isoquant on a graph with fertilizer on the horizontal axis and soil on the vertical axis.
- (b) Suppose that in the short run, the farmer has 50 units of soil and is unable to buy any more for the season. The farmer can buy any amount of fertilizer he wants. If the farmer is maximizing profits, how much fertilizer will the farmer use and what profits will the farmer make?
- (c) Suppose instead that the farmer has 100 units of fertilizer and cannot purchase any more this season. The farmer can purchase as much soil as he wants. If the farmer is maximizing profits, how much soil will the farmer want to use in the short run? Be certain to fully justify your answer.
- (d) Now consider the long run in which both soil and fertilizer are variable inputs. Derive expressions for the amount of fertilizer the farmer will use as a function of zucchini ( $F(Z)$ ) and the amount of soil the farmer will use as a function of zucchini ( $S(Z)$ ) assuming that the farmer minimizes costs. *Note: You can assume that the farmer is only considering producing large quantities of zucchini ( $Z > 100$ ).*

4. (25 points) The demand for gallons of gasoline ( $G$ ) is given by the following inverse demand function:

$$p(G) = 10 - \frac{1}{10}G \quad (4)$$

The supply of gasoline is given by the following supply function:

$$S(p) = 10p \quad (5)$$

where  $p$  is the price per gallon of gasoline. Assume that the number of gas stations is fixed (there is no entry or exit of gas stations).

- (a) Find the equilibrium price and quantity gasoline.
- (b) The state decides to impose a 50% sales tax on gasoline for consumers. Consumers must pay this tax when filing their income tax returns (the tax is not collected by the gas station). What will the new equilibrium price for a gallon of gasoline at gas stations be (the price that is actually paid to the gas station) and what will the new equilibrium quantity of gasoline be?
- (c) Calculate the tax revenue and the deadweight loss generated by this tax.
- (d) How would your answers to (b) and (c) have changed if the gas stations were responsible for submitting the tax to the government? Be as specific as possible.