ECO 601
Fall 1998
2nd Test

1. (15 pts.) Crude oil is carried by pipelines from oil fields and storage areas over hundreds of miles to urban and industrial centers. The output of such pipelines is the amount of oil carried per day, and the two principal inputs are the diameter of the pipeline and the horsepower applied to the oil carried. It has been estimated that the production function for a pipeline with a 10-inch diameter is: $Q = 286H^{.37}$, where Q is the amount of crude oil carried per day and H is horsepower.
a) Derive a formula for the marginal product of horsepower.
b) Do increases in horsepower result in diminishing marginal returns?
c) Derive a formula for the average product of horsepower.
d) If the marginal revenue from an extra unit of crude oil carried per day is $2, what is the marginal revenue product of horsepower?
e) If an oil pipeline firm can add all of the horsepower it wants at a price of $30 per unit of horsepower, how much horsepower should be used?

2. (30 pts.) Arby's produces roast beef sandwiches according to the production function $q=10K^{.5}L^{.5}$, where q is the number of roast beef sandwiches per hour and K and L refer to inputs of capital and labor per hour.
a) On the accompanying sheet of graph paper plot isoquants for q=40 and q=80.
b) To produce 20 roast beef sandwiches per hour Arby's could use either (K=4, L=1) or (K=2, L=2). What is the elasticity of substitution between capital and labor over this range of the q=20 isoquant? (Hint: a complete answer will define elasticity of substitution and either compute it between the two points on the isoquant or solve for it algebraically.)
c) Suppose the hourly wage rate is $5 and the hourly rental rate on capital is $20. In a typical hour we serve 40 roast beef sandwiches to our customers. Solve for and then illustrate in your diagram the cost-minimizing combination of K and L.

3. (20 pts.) Illustrated below is the long-run total cost curve for a particular firm. Also included in the diagram are three short-run total cost curves associated with fixed levels of capital K_0, K_1, and K_2. On the attached sheet of graph paper sketch the long-run average and marginal cost curves for this firm, as well as the three short-run average and marginal cost curves corresponding to fixed levels of capital K_0, K_1, and K_2. Pay careful attention to points of tangency and points of intersection in drawing your diagram.   [see Nicholson p. 322, Figure 12.8b]

4. (20 pts.) Consider a competitive industry with insignificant entry and exit barriers. The industry is composed of identical firms with U-shaped average total cost curves. Initially the industry is in long-run equilibrium. Assume that input prices and technology do not change. A large, annual fixed license fee is suddenly imposed on all firms in the industry. The license fee must be paid on January 1 of each succeeding year by all firms that choose to stay in business.
a) How does each firm's rate of output change in the short run?
b) What happens to the long-run equilibrium number of firms?
c) How does the rate of output change for each of the surviving firms?
d) What happens to long-run equilibrium price?

5. (15 pts.) A monopolist faces the following demand function for its product: $Q = 45 – 5P$. The fixed costs of the monopolist are $12 and the monopolist incurs variable costs of $5 per unit produced.
a) What is the profit-maximizing level of price and quantity for this monopolist?
b) If the government imposes a fixed franchise tax on the firm of $10, what will be the profit-maximizing level of price and output?
c) If the government imposes an excise tax of $.50 per unit of output sold, what is the impact on the profit-maximizing level of price and output?

1. (15 pts.) As output in the aluminum industry increases, the cost of bauxite is bid up. Bauxite, the raw material from which aluminum is made, has a long-run supply curve that is upward sloping. Hence, aluminum is an increasing cost industry. Suppose that one aluminum producer owns its own bauxite supply. Do that firm's costs increase when industry output expands? Why can't that firm keep its costs lower than its competitors and earn positive economic profits from selling aluminum?

2. (25 pts.) Arby's produces roast beef sandwiches according to the production function $q=10K^{.5}L^{.5}$, where q is the number of roast beef sandwiches per hour and K and L refer to inputs of capital and labor per hour.
   a) During a normal lunch hour, 120 customers show up and order roast beef sandwiches. In an isoquant diagram, illustrate the different combinations of K and L that can be used to produce this output.
   b) Suppose w=6 and v=6. What combination of L and K will minimize costs for q=120?
   c) What is marginal cost if the firm uses this combination to produce q=120?

3. (30 pts.) Suppose you own another Arby's on the other side of town. The same production function applies to this restaurant. When you built this restaurant, you anticipated that your desired output would be 80 sandwiches per hour, and so you selected K=8 for this restaurant. Now that you have built it, you are stuck in the short run with this amount of capital. Suppose that your *ex ante* forecast of demand turns out to be wrong, and that 120 customers per hour want to buy roast beef sandwiches at this restaurant.
   a) Illustrate the short-run combination of K and L you would use to produce q=120, and then show the isocost line associate with this input combination. What is total cost?
   b) Are you under or over-utilizing capital relative to labor? Explain by computing marginal products and using the optimality condition for cost minimization.
   c) In a diagram, illustrate the LRAC curve for this restaurant, and show the SRAC curve associated with K=8. Briefly explain how your answer to (b) shows up in this diagram.

4. (30 pts.) Suppose that the tobacco market is in long-run equilibrium at a price of $1.50 per pound, and imagine for sake of argumentation that there is absolutely no government intervention in this market. Also suppose that tobacco farming is characterized by a U-shaped long-run average cost curve. Market price elasticity of demand in this perfectly competitive industry is 1.0.
   a) Now, suppose that as a part of the recent tobacco lawsuit settlements, the Department of Agriculture implements a program that requires each tobacco farmer to restrict its tobacco output by 10%, and that it permits no new entry into tobacco farming. Show in diagrams each firm's output and the collective effect on the market price of tobacco. Do you think that tobacco farmers would support such a program? Using your diagram, briefly explain why or why not.
   b) Suppose that instead of requiring each producer to restrict output, the USDA issues operating licenses to tobacco farmers. A lottery is held, and 90% of tobacco farmers get a license to grow tobacco. Obviously the unlucky 10% have to find some other line of business to go into, since they can no longer grow tobacco. Now for the question: Will short-run output fall by 10%? What will happen to the market price of tobacco? Show in a diagram the short-run output and profits of one of the lucky tobacco farmers who was granted a license to grow tobacco.