Homework Policy:
Study You can study the homework on your own or with a group of fellow students. You should feel free to consult notes, text books and so forth.

The quiz will be available Wednesday at 5pm. Following the Honor code, you should find 20 minutes and do the quiz, by yourself and without using any notes. Paper and pen should be all you need. Then turn it in by Thursday 5pm. (drop off in box in front of Baxter 133). It will include one question from each section

The answers to the whole homework will be available Friday at 2pm.

Definitions
Please explain each term in three lines or less!

- Shadow value
- Marginal product
- Marginal cost
- Short-run marginal cost
- Short-run average cost of production
- Revealed preference
- Fixed costs
- Total Factor Productivity

Word problems
Please explain each question in a few sentences.

- Consider fixed capital, what are the implications of the first order condition of the profit maximization problem? What does the second order condition imply?
- Why do ships and taxis go at slower speeds as a short run adjustment to recessions?
• Sketch the average total cost (ATC), average variable cost (AVC) and marginal cost (MC) of a firm (dollars vs. quantity). Why does the MC curve necessarily intersect at the minimum of the AVC and ATC curves?

• Why does a profit-maximizing firm produce the quantity \( q_s \), where price equals marginal cost, given price is as large as minimum average variable cost? Why does a profit-maximizing firm shut down if the price falls below the minimum average variable cost of production?

• What does \( \frac{\partial^2 f}{\partial K \partial L} < 0 \) and \( \frac{\partial^2 f}{\partial K \partial L} > 0 \), where \( f(K, L) \) is the production function and \( K \) and \( L \) are capital and labor, imply about labor and capital? Provide an example of each case and draw the respective isoquants.

• Suppose we have a profit-maximizing firm and \( p \) is the fixed optimum price required. What does a decline in price imply about cost of production? What does an increase in wages imply about labor productivity?

**Technical problems**

• Suppose a company has total cost given by \( rK + \frac{q^2}{2K} \) where capital \( K \) is fixed in the short-run.
  - What is the short-run average total cost and marginal cost? Plot these curves.
  - For a given quantity \( q_0 \), what level of capital minimizes total cost? What is the minimum average total cost of \( q_0 \)?
  - Suppose capital \( K \) can be adjusted in the long-run. Does this company have an increasing return to scale, decreasing returns to scale or constant returns to scale?

• **Professor Smith and Professor Jones are going to write a textbook together.** Their production function for the book is \( q = S^{1/2} J^{1/2} \), where \( q \) is the number of pages in the finished book, \( S \) is the number of working hours spent by Smith, and \( J \) is the number of hours spent working by Jones. Smith values his labor as $3 per working hour. He has spent 900 hours preparing for the first draft. Jones, whose labor is valued at $12 per working hour, will revise Smith’s draft to complete the book.
  - How many hours will Jones have to spend to produce a finished book of 150 pages? Of 300 pages? Of 450 pages?
  - What is the marginal cost of the 150th pages of the finished book? Of the 300th page? Of the 450th page?

• A lawn mowing company uses two sizes of mowers to cut lawns. The smaller mowers have a 24-inch blade and are used on lawns with many trees and obstacles. The larger mowers are exactly twice as big as the smaller mowers and are used on open lawns where maneuverability is not so difficult. The two production functions available to the company are\(^1\):

\(^1\) Nicholson’s *Microeconomic Theory*
<table>
<thead>
<tr>
<th></th>
<th>Output (square feet)</th>
<th>Capital input (# of 24'' mowers)</th>
<th>Labor input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger mowers</td>
<td>8000</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Small mowers</td>
<td>5000</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

- Graph the $q = 40000$ square feet isoquant for the first production function. How much $K$ and $L$ would be used if these factors were combined without waste?
- Answer the previous part for the second function.
- How much $K$ and $L$ would be used without waste if half of the 40000-square-foot lawn were cut by the method of the first production function and half by the method of the second? How much $K$ and $L$ would be used if $3/4$ of the lawn were cut by the first method and $1/4$ were cut by the second? What does it mean to speak of fractions of $K$ and $L$?
- On the basis of your observations in the previous part, draw a $q = 40000$ isoquant for the combined production functions.
- Suppose a gardener is going to go into business. She has access to both technologies what is the optimal number of mower of each type that she should purchase in order to minimize costs? When she hires workers or rents mowers she had to do it in whole hours the wage is $10$ per hour; the rental cost of a unit of capital is $5$ per hour.