

Written answers are acceptable so long as they are legible. Remember, you can work with others but you must write the answers on your own. IF YOU WORK WITH OTHERS YOU MUST NOTE WITH WHOM YOU WORKED IN YOUR ANSWER.

## Problem 1

Suppose that a legislative body composed of three people is voting on a single issue: taxes. Each voter has a “ideal” level of taxation which can range from 0 to 100%. Each voter prefers that the level of taxation be as close to their ideal point as possible. In order for a level of taxation to pass it must secure a majority of votes.

Each legislator has a strategy: pick a proposal  $p$  to vote on. If two or more legislators vote on a particular  $p$ , it passes and every legislator gets paid according to how close  $p$  is to their ideal point.

For convenience you can assume that no two legislators share the same ideal point. Is the Core in this game empty? If it is, illustrate how you came to this conclusion. If not, what strategy sets are in the Core?

## Problem 2

Suppose there is a group (more than 2) of players that must choose a real number between 1 and 100. The person who is closest to the average of the other players gets paid \$1. If more than one person is equally close, they split the dollar equally among them. What are the Nash equilibria of this game?

## Problem 3

Do problem 20 on page 518 of the textbook.

## Problem 4

A strict Nash equilibrium is a Nash equilibrium where unilateral deviations by any player will make that player strictly worse off – no player is indifferent between performing her part of the equilibrium and some other action. Are any mixed strategy Nash equilibria strict? If you answer yes, give an example. If you answer no, prove why no mixed strategy Nash equilibria can be strict.

## Graduate student problems (extra credit for undergrads)

### Problem 5

Suppose Sally and David must decide how to divide a dollar. Sally's utility function for a fraction of a dollar is  $u_s(x) = \ln(4x + 1)$ , David's is  $u_d(x) = \ln(3x + 1)$ . What are the utilitarian, egalitarian, and Nash bargaining solutions to this problem? (Assume for the Nash bargaining solution that the breakdown and deadlock points are (0,0) and the bargaining powers are equal.) What are Sally's and David's utilities in each of these outcomes?

Numerical approximations are acceptable.

### Problem 6

A game is said to have a *non-trivial extensive form* if there is no way to represent the game where each player has only one information set (where they make a decision with at least two options). Effectively, this means that at least one player acts later than another and is able to observe the actions of that other player before acting. Prove that every Nash equilibrium a game with a non-trivial extensive form and no moves by nature is *not* strict.

What does this say about ESS in these games? Can non-trivial extensive form games (without moves by nature) have an ESS?