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.

We will not have class when this homework is due. Please turn it in either electronically to kzollman@andrew.cmu.edu or in Kevin Zollman's box in Baker Hall 135.

Problem 1

What are all of the pure and mixed strategy Nash equilibria of the following game:

	A	B
A	2, 3	0, 0
B	1, 1	4, 2

Problem 2

Remember the congestion game from the last homework. There are three people who must choose one of two routes, route A and route B. To make the game more concrete, suppose that the payoff for driving by yourself is 10, for driving on a route with one other person is 7, and with two other people is 0. What are all the pure and mixed strategy Nash equilibria of this game?

Hint: Each player is flipping an independent coin, so the probability that player 2 and player 3 both choose route A is equal to: (the probability that player 2 chooses route A) $\times$ (the probability that player 3 chooses route A).

Problem 3

Consider the following simple modification of the ultimatum game. The first player proposes one of two possible splits of $20. One split is fair, $10 for both players. The other split is very good for player *two*, it gives $2 to player *one* and $18 to player *two*.

After learning of the offer from player one the second player can accept the offer, in which case they both get what the first player proposes, or she can reject. If the second player rejects, four dollars are wasted and the second player can propose one of two counter-offers to player one. One potential offer splits the remaining money evenly, $8 to both players. The other potential offer is good for player *two*, it gives $1 to player *one* and $15 to player *two*.

Part A: Draw the extensive form.

Part B: Find the subgame perfect Nash equilibrium.

Part C: Find two Nash equilibria that are not subgame perfect.

Extra-credit

Problem 4

Consider the generalized version of what we just did. Player one chooses a split to offer to player two, $x \in [0, 1]$. Player two observes player one's offer has two options: she can accept in which case she gets $(1 - x)$ and player one gets x or she can reject. If she rejects she makes a counter-proposal, but because they are taking too long the pie shrinks – player two chooses a $y \in [0, \delta]$ where $0 < \delta < 1$. Player one can then either accept the counterproposal in which case player one gets $(\delta - y)$ and player two gets y or he can reject. If player one rejects they both get 0.

What are the subgame perfect equilibria of this game? (You may make a few simplifying assumptions about what the players do when indifferent or the general properties of their strategies if you think it might help.)

Problem 5

Consider an infinite sequence of games like the one above. each that last one extra round than the last. If player one rejects the counter-proposal, he can make a counter-counter-proposal in $[0, \delta^2]$ and then player 2 can make a counter-counter-counter-proposal in $[0.\delta^3]$, etc.

Describe the sequence of subgame perfect equilibria for this sequence of games. Does it converge? If so, to what? Prove what you claim.