Do NOT write your name anywhere. (Canvas will tell me who turned in the exam.) Take pictures of your answers and use your own software or https://pdfcandy.com/ to create a PDF for each answer which requires an upload. If it is large, resize it to A4. Upload that to Canvas. Upload each answer as a separate file with that question. Failure to follow directions will cost you one point. People with Apple products may need to us CamScanner app.

You are not allowed to use your books, notes, the internet, or other people when taking this test. You can use the internet to access Canvas and to convert your answers to PDF files. Nothing else.

If you run out of time or lose your internet connection, you can do a second submission. You do NOT have to redo the questions you already did. I will be able to see every submission. If you have problems, you can always contact me via Zoom or e-mail. If you use Zoom, open it in a new tab or window.

Failure to follow these directions will cost you 1 point. The test has 100 points (to be scaled up to 250 points) and is scheduled to take 50 minutes. Therefore, expect to spend 1 minute for every 2 points. For example, a 12-point question should take 6 minutes. I have it set up to only give you an hour and a half.

Show all work on all questions.

1) (10 points) Answer EITHER Part A OR Part B.
A) For a valid utility function, what must be true about the first derivatives? What is the economic reason for that? For a valid utility function, what types of returns to scales must we have? What is the economic reason for that?
B) When we had an intertemporal budget constraint with an interest rate of 10% and a utility function given by $U = C_0^{1/5}C_1^{1/5}C_2^{1/5}C_3^{1/5}$, we found that even though the utility function values consumption now the same as it values consumption next year etc., we ended up buying 10% more things in each consecutive year. What is the economic reason for this? Explain your logic. Hint: what else determines the ratio of how much you buy other than your utility function?

2) (16 points) Answer EITHER Part A OR Part B.
A) Suppose your utility from learning (i.e. better grade) and video games is given by $U(L,V)=8L^{1/4}V^{1/2}$. They both take the same amount of time, 1/hr per unit of studying and 1/hr per unit of playing video games. You have 15 hours of time awake when you are not eating. How much time do you spend on each activity? About how much additional utility would you get if you could cut your sleep by 2 hours?
B) Suppose your utility from hats and vests is given by $U(H,V) = 8H^{1/2}V^{1/4}$. Hats cost $20/hat and vests cost $80/vest. How many of each would you buy if you had $480 to spend on hats and vests? (I realize that spending that much on hats and vests is unrealistic.) What is your marginal utility of income?

3) (18 points) Find all Nash equilibria in the following matrix, if any exist. Prove that you found all and prove they are Nash equilibria. Does either team have a dominant strategy? How can you tell? Find the cooperative equilibrium. Explain how you found it. What are the two players' secure strategies? How did you find them?

4) (28 points each) Do TWO of the following parts.
A) Suppose that a Cournot style duopoly has a demand curve $P = 400 - (Q_1 + Q_2)$ and both firms have a cost function $TC_i = 3Q_i^2 + 100Q_i + 10$. Find each firm's best response function. Find the equilibrium quantities for both firms, price, and profits. Set up the Lagrangian for the Von Stackelberg leader. Briefly state how you got it. Take the first derivatives, but do NOT calculate the Von Stackelberg.
B) Suppose your utility function for apples, bananas, and pears is given by $U(A,B,P)=8A^{1/4}B^{1/2}P^{1/8}$. The price of an apple is $4/apple. The price of a banana is $2/banana. The price of a pear is $4/pear. It takes 2 minutes to skin an apple and 1 minute to peel a banana. However, pears are not peeled. If you have $48 and can spend 24 minutes peeling fruit, then how many of each would you buy?
C) Suppose the production function is given by $Q = 6K^{1/3}L^{1/6}$. The wage rate is $20/hour and capital rents for $40/hour. Find the λ, total cost, marginal cost, and average total cost functions as a function of Q.

Payoff Matrix		Steelers	
		High price	Medium Price
Patriots	High Price	14 9	3 8
	Low Price	13 11	5 12