

General Instructions: This exam is worth **200 points**. You are allowed to use your notes. You are allowed to use a calculator. You must show all your work when appropriate to get credit. This includes showing all applicable formulas you use. You can either submit it to me by uploading the file to Canvas, which is preferable, or you can send it to me by email. A PDF would be preferred, but it is OK to submit photos of your work. I ask that you please review your submission before you send it to me, to make sure I can read it. Specifically, please make sure that all answers are upright so I do not have to look at them sideways or upside down. You need to submit this exam to me within 5 hours from when you are scheduled to take the exam unless you are registered with the DRC. You will be penalized a point for every minute the exam is late. You are not allowed to work with anyone on the exam. **At the end of the exam, you need to attest that you received no assistance from anyone else when taking the exam.** (Good Luck!)

Question 1 (100 Points Total):

Mandy's Candy is a small purveyor of selling unique artisanal fine chocolates. The owner, Mandy Panvirus, has had a tough time managing to stay in business over the last six months due to the global pandemic and the associated lock down of local businesses. As the holiday season arrives, Mandy's mood has been much more optimistic because she just finished a class on how to sell products over the internet. In preparation for selling her products over the internet, Mandy has just purchased a web domain name for \$3,181. Mandy considers this a fixed cost of doing business online.

As Mandy considers all the different types of chocolate she crafts that she can sell online, she has decided on a strategy of focusing on one specific chocolate bar that she will sell online. The purpose of focusing on one chocolate bar is so she can ensure that she can deliver whatever is demanded of her product. Being new to online selling and having a desire to obtain the highest profit possible, Mandy after doing some market research has decided to sell a single 3 oz. chocolate bar for \$6.

Mandy's chocolate bar has four key ingredients: almonds, nutmeg, dried fruit, and Yacon syrup. She believes that this particular chocolate bar will sell extraordinarily well online due to its unique sweetener of Yacon syrup, which comes from the roots of the Yacon plant that is native to the Andes Mountains and has a low glycemic sugar index. Mandy has spent time researching the cost of her key ingredients. She has found that a local nut grower will sell her fresh almonds for \$576 per 500 pound box. She can purchase the nutmeg and dried fruit from Fruity Meg's at a cost of \$36 per 12 oz. jar of nutmeg and the dried fruit for \$4 per pound. Mandy has considered herself quite lucky because she has come across an online dealer who sells Yacon syrup for \$9 per 5 oz. jar.

Since Mandy has been making these special chocolate bars for a while, she has a very good understanding of the process to make the chocolate bars. She has a special machine that she uses

for mixing the ingredients together. Her experience with this machine over the years has given her a good idea of what her production function is. Specifically, her production function can be represented by the following:

$$C = f(A, N, D, Y) = 3(7A^2 + 32A + 24N) + 2(9D^{1/6}Y^{1/8})^2 - (A^3 + N^2);$$

where C represents a single 3 oz. chocolate bar, A represents a 500 pound box of almonds, N denotes the number of 12 oz. jars of nutmeg, D represents a pound of dried fruit, and Y represents a 5 ounce jar of Yacon syrup. The expected fixed cost for the depreciation of the machine is estimated at \$10,000.

Please answer the following questions making sure to give proper justification:

- A) At the current given prices, what is the optimal amount of profit that Mandy can expect to make for producing the optimal number of chocolate bars assuming that he can sell all that she produces? **(50 Points)**
- B) Suppose that Mandy decides to not use the dried fruit or Yacon syrup. How much profit would she lose if she decided to maximize her production of chocolate bars rather than profit? **(25 Points)**
- C) Given the input prices, what is the tradeoff between almonds and nutmeg at the optimal input allocation? **(15 Points)**
- D) What is the marginal cost of production for nutmeg at the optimal input? Please explain how you got your answer. **(10 Points)**

Question 2 (80 Points Total):

Fruity Meg's has been a drier of spices and fruits for the last sixty years. Her reputation is so strong that she is known for her drying capabilities internationally. She just received a purchase order from Mandy Panvirus to purchase as much nutmeg and dried fruit that Fruity Meg's is willing to produce. The sales representative negotiated a price of \$36 per 12 oz. jar of nutmeg and \$4 per pound of mixed dried fruit.

Fruity Meg has one large scale drier that is capable of drying both fruits and spices. This machine in a production cycle has 1,552 hours available for use in drying. The drier can be allocated to drying nutmeg and fruit in any combination of hours. The cost to operate this drier is \$18 per hour and has a depreciation fixed cost of \$3,808 per production cycle.

Given the company's long history in drying fruits and spices, it has a very good data that was used to estimate the productivity level of the drier when it comes to drying fruits or spices. In terms of drying spices, past data indicates that a production function for drying nutmeg can be represented as the following: $N = f(T_N) = 432T_N^{1/4}$, where N represents the number of 12 oz. jars of nutmeg and T_N denotes the amount of hours devoted to drying nutmeg. The drier that Fruity Meg's has available is quite a bit more efficient for drying fruit. Past production data shows that the production function for drying fruit can be represented as:

$D = f(T_D) = 1152T_D^{1/4}$, where D denotes the number of pounds of dried fruit produced and T_D represents the number of hours devoted to drying a pound of dried fruit.

Once the fruit and spice have been dried, they must go through the packaging machines that Fruity Meg's has. These packaging machines can handle as much fruit and spices as Fruity Meg's can produce. Since they have constant returns to scale, they do not lose or gain efficiency with more of less product being handled. The depreciation fixed cost for the spice bottler is \$4,000, while the dried fruit packager has a depreciation fixed cost of \$6,000.

Please answer the following questions making sure to give proper justification:

- A) What is the optimal profit at the optimal solution for Fruity Meg's given the prices Mandy would currently like to pay? If you solve this problem using MVP's, you will lose 15 points. **(50 Points)**
- B) Graph the optimal solution. Be sure to use revenue rather than profit when you are graphing the optimal solution. **(20 Points)**
- C) If Mandy's chocolate bars are a big hit and she is willing to increase her price for dried fruit to \$12, how much would the sales representative from Fruity Meg's need to increase the price of nutmeg so that the production decision for Fruity meg's does not change, i.e., they would produce the same output? Please explain. **(10 Points)**

Question 3 (20 Points Total):

Suppose that Mandy's Candy is about to launch its online website. Before she launches, she has decided to do a competitive analysis to see who her key competitors are. She has come across one company that she believe she will be competing with directly. This company is known as Holiday Confections. Holiday Confections is a leading online retailer who guards its market share and profits carefully through strategic decisions it makes regarding the items it focuses on for selling in the holiday season.

Mandy's research has shown that Holiday Confections employs five key strategies when a new competitor comes to the marketplace based on its past history. She believes these are the key strategies that Holiday Confection may use against her as she enters the market. The first strategy it has done in the past is to focus its sales effort on selling boxes of chocolates (SBC). The second strategy the company has done is focus its sales effort on selling chocolate gift baskets (SCGB). The third sales strategy has focused on selling multi-bar packs (SMBP). Selling non-chocolate gift baskets (SNCGB) is a fourth strategy it has employed in the past. The final strategy Holiday Confection typically employed was selling non-chocolate gift packages (SNCGP).

When Mandy was initially thinking about conducting online sales, she was only considering one strategy, which was to sell single bars (SSB). Now that she knows that Holiday Confections will directly compete with her, she has devised two other strategies. The second strategy that Mandy believes she can do is to sell packages of bars (SPB), rather than selling single bars. A third

strategy she has developed is to sell a mixture gift baskets (SMGB), which has multiple chocolate bars that she makes.

The table below represents the payoffs for each candy company in terms of weekly gross profits. You should assume that each company knows the potential strategies and payoffs of the other company and is trying to maximize its weekly profits. It should also be assumed that each company has to make its decision without knowing the decision of the other company. Holiday confections payoffs are listed first and Mandy’s Candy is listed second.

		Mandy’s Candy		
		Sell Single Bars (SSB)	Sell Package of Bars (SPB)	Sell Mixture Gift Basket (SMGB)
Holiday Confections	Sell Box of Chocolates (SBC)	718 , 365	462, 908	646 , 114
	Sell Chocolate Gift Basket (SCGB)	142 , 293	115 , 389	842 , 33
	Sell Multi-Bar Pack (SMBP)	575 , 256	733 , 784	89 , 23
	Sell Non-Chocolate Gift Basket (SNCGB)	344 , 438	141 , 513	953 , 720
	Sell Non-Chocolate Gift Package (SNCGP)	614 , 280	250 , 742	640, 240

Please answer the following questions:

- A) Are there any dominant or dominated strategies for either candy company? If so, what is it or are they? **(5 Points)**
- B) What is/are all the Nash equilibrium? **(5 Points)**
- C) If Mandy decides to advertise her strategy first for Holiday Confection to see before it makes its decision on strategy, which strategy would each decide to employ based on the idea of the Rollback equilibrium? Please explain. **(10 Points)**

To get credit for this exam, you will need to write out at the bottom of the exam that you submit the following statement with a signature after it:

I attest that I received no assistance from anyone when I took this exam.

If this statement is missing and not signed, you will receive a 20% deduction for the exam.