Make sure to follow the instructions:

- The collection of this project will be done on CoCalc only on Friday, December 20, at 11:59 pm.

- E-mail submission will not be accepted.

- Go to the course project (not the shared project) and look for the folder named Project 3. In this folder you will find a file named "yourlastname_proj3". Rename it by changing "yourlastname" to your actual last name. This file is ready for your to run the linear programming scripts. This is where you will work on.

- When you are done, leave a pdf version of your homework in the same folder.

- No late submission will be accepted.

Problems 15 and 21. The Burningham textiles company has three textile mills located in the southern U.S. and four distribution centers located in Michigan, New York, California, and Georgia. The estimated yearly output from each mill, the allocation to each warehouse, and the shipping costs are tabulated in the table below.

		MI	NY	CA	GA	Output
	1	430	550	680	700	105
Textile Mill	2	510	590	890	685	160
	3	395	425	910	450	85
Allocation		70	100	105	75	

Table 3.7: Data for the transportation problem of Exercise 15. Shipping cost per truckload in dollars.

(a) Find the transportation plan that minimizes shipping costs. Use the five-step method, and solve as a linear programming problem using a computer.

(b) Determine the shadow prices for each of the output constraints. Would it be beneficial to shift production capacity from one mill to another? How much should the company be willing to spend to facilitate the shift?

(c) The company has purchased three new trucks for shipping. The new trucks are more fuel-efficient, and are expected to reduce shipping costs by 50%. Assume that one truck can make one trip per week (52 per year), and that each route will use either all old or all new trucks. How should the company use the new trucks in order to maximize their cost savings? Use the five-step method, and solve as an integer programming problem using a computer.

(d) Perform a sensitivity analysis on the number of new trucks. Determine the optimal shipping plan and the expected cost savings for $n = 4, 5, 6$, and 7 new trucks. If the cost of a new truck is $12,000$ per year amortized over the expected life of the vehicle, how many additional trucks should the company purchase?

(e) Because the State of California has instituted new pollution laws for trucks, the company must use the new trucks to ship to CA. How does this change the results of parts (c) and (d)? What do the new CA pollution laws cost the company?

Problem 16. A manufacturer of personal computers sells three desktop models. Model A costs $850 to manufacture and sells for $1,250; model B costs $950 to manufacture and sells for $1,400; and model C costs $1,500 to manufacture and sells for $2,500. The company purchases 10,000 desktop cases each month, and each computer requires one case. Models A and B use a 15-inch monitor, and the company can obtain 5,000 of these monitors per month. Model C uses a 17-inch monitor, and 7,500 of these are available per month. The remaining components are freely available. The company has 20,000 hours of production capacity available per month, and the production of each unit of model A, B, and C requires 1, 1.25, and 1.75 hours respectively.

(a) How many of each type of computer should the company produce? Use the five-step method and solve as a linear programming problem.

(b) Determine the constraints that are binding. Determine the shadow prices for each constraint. Explain what each shadow price means in the context of this problem.

(c) Next month, the company plans to put model C computers on sale for $2,199. How does this change the results of parts (a) and (b)?

(d) The company is considering a new desktop model D. This model will cost $1,250 to manufacture and will sell for $1,895. It requires a desktop case, a 17-inch monitor, and 1.5 hours of production. How will this change the results of parts (a) and (b)? Would you advise the company to go ahead with their plans to introduce this new model?

For Problems 15/21:

1. What do we want to minimize? (in words)

2. Based on the table, what is the shipping cost between the Textile Mill 1 and Michigan? Include the units.

3. In order to calculate the total shipping cost between the Textile Mill 1 and Michigan, which other variable will you need? Include the units.

4. What is the total shipping cost between the Textile Mill 1 and Michigan? Include the units.

5. There are three textile mills and four distribution centers. How are you going to generalize the variable you introduced in (3) using one single notation? Redefine the variable you will use. Be precise.

6. What does the number 105 on the table represent?

7. Among the variables you defined in (5), which ones are related to the number 105? Explain this relationship in words.

8. How can you relate the information in (6) and (7)? Write down the mathematical expression.

9. Repeat the reasoning from (6)-(8) to the numbers 160 and 85 on the table?

10. What does the number 70 on the table represent?

11. Among the variables you defined in (5), which ones are related to the number 70? Explain this relationship in words.

12. How can you relate the information in (10) and (11)? Write down the mathematical expression.

13. Repeat the reasoning from (10)-(12) to the numbers 100, 105 and 75 on the table?

14. Write down the function that represents the total shipping cost.

15. Identify the objective function and all the constraints.