

# ALY-6050 Module 6 Project

## Project: Two Optimization Problems:

- (i) *A Transshipment Problem*
- (ii) *A Risk Minimizing Problem*

The Module 6 Project consists of two parts. If using Excel, complete each part in a separate worksheet of the same Excel workbook (Name your worksheets: “Part 1” and “Part 2”). If using R, complete each part in a separate R script file. The submission of this project will consist of an Excel workbook (or two R script files if R has been used) and a report (.docx or .pdf). The report should follow APA standards, i.e., it consists of a title page (including student’s name, assignment title, course number and title, the current academic term, instructor’s name, and the assignment completion date), and a reference page. The report will consist of three sections:

- (i) Introduction
- (ii) Analysis
- (iii) Conclusion

## Part 1: Rockhill Shipping & Transport Company

Allen, a manager of the South-Atlantic office of the Rockhill Shipping & Transport Company is negotiating a new shipping contract with Chimotoxic, a company that manufactures chemicals for industrial use. Chimotoxic wants Rockhill to pick up and transport waste products from its six plants to three waste disposal sites. Allen is very concerned about this proposal arrangement. The chemical wastes that will be hauled can be hazardous to humans or the environment if they leak. In addition, some of the communities in the regions where the plants are located may prohibit hazardous materials from being shipped through their municipal limits. Thus, not only the shipments have to be handled carefully and transported at reduced speeds, but they may also have to traverse in circuitous routes in some cases.

Allen has estimated the cost of shipping a barrel of waste from each of the six plants to each of the three waste disposal sites as shown in the following table.

Plant:	Waste Proposal Site		
	Orangeburg	Florence	Macon
Denver	\$12	\$15	\$17
Morganton	14	9	10
Morrisville	13	20	11
Pineville	17	16	19
Rockhill	7	14	12
Statesville	22	16	18

Table 1: Shipping costs, per barrel of waste from six plants to three waste disposal sites

The plants generate the following amounts of waste products each week:

**Northeastern University**  
**ALY-6050**

Plant:	Waste per Week (bbl)
Denver	45
Morganton	26
Morrisville	42
Pineville	53
Rockhill	29
Statesville	38

Table 2: Total Waste generated by each plant

The three waste disposal sites at Orangeburg, Florence, and Macon can respectively accommodate a maximum of 65, 80, and 105 barrels per week.

In addition to shipping directly from each of the six plants to one of the three waste disposal sites, Allen is also considering using each of the plants and the waste disposal sites as intermediate shipping points. In this case, trucks would be able to drop a load at a plant or a disposal site to be picked up and carried on to the final destination by another truck. Furthermore, Rockhill would not incur any handling costs because Chimitoxic has agreed to take care of all the handling costs at the plants and at the disposal sites. In other words, Rockhill's only cost will be the transportation cost. Therefore, Allen wants to be able to consider the possibility that it may be cheaper to drop and pick up loads at intermediate points rather than ship them directly.

Allen has estimated the shipping costs per barrel between each of the six plants to be as follows:

	Plant					
Plant:	Denver	Morganton	Morrisville	Pineville	Rockhill	Statesville
Denver	\$---	\$3	\$4	\$9	\$5	\$4
Morganton	6	---	7	6	9	4
Morrisville	5	7	---	3	4	9
Pineville	5	4	3	---	3	11
Rockhill	5	9	5	3	---	14
Statesville	4	7	11	12	8	---

Table 3: Shipping costs, per barrel of waste from each plant to another plant

The estimated shipping cost per barrel between each of the waste disposal sites is as follows:

	Waste Proposal Site		
Waste Disposal Site:	Orangeburg	Florence	Macon
Orangeburg	\$---	\$12	\$10
Florence	12	---	15
Macon	10	15	---

Table 4: Shipping costs, per barrel of waste between the three waste disposal sites

Allen wants to determine the shipping routes that will minimize Rockhill's total cost in order to

**Northeastern University**  
**ALY-6050**

develop a contract proposal to submit to Chimotoxic for waste proposal. He particularly wants to know if it would be cheaper to ship directly from the plants to the waste sites or if he should drop and pick up some loads at the various plants and waste sites.

In the word document, explain the details of the solutions obtained for the optimal routes and their respective optimal costs for both cases. In particular for the case when loads are dropped and picked up at various plants and waste sites, explain how many barrels, in total, will be transported each week from a source to a destination.

## Part 2: Investment Allocations

An investor has selected the following asset types in his portfolio. The expected return for each asset type has been estimated by using the historical data:

	Expected Returns
Bonds	7%
High tech stocks	12%
Foreign stocks	11%
Call options	14%
Put options	14%
Gold	9%

Table 5: Expected returns of Investments

The following table indicates the covariance matrix of the assets' returns. Each diagonal entry is the variance of an asset and non-diagonal entries are the covariances between any pairs of assets.

	Bonds	High tech stocks	Foreign stocks	Call options	Put options	Gold
Bonds	0.001	0.0003	-0.0003	0.00035	-0.00035	0.0004
High tech stocks		0.009	0.0004	0.0016	-0.0016	0.0006
Foreign stocks			0.008	0.0015	-0.0055	-0.0007
Call options				0.012	-0.0005	0.0008
Put options					0.012	-0.0008
Gold						0.005

Table 6: The Covariance matrix of assets' returns

- (i) Suppose that our investor wishes to invest \$10,000 in this portfolio. Determine how he should allocate this investment to the individual assets in his portfolio in order to have a minimum baseline expected return of 11%, and at the same time, at a minimum risk.
- (ii) Let the solution pair be denoted by  $(r, e)$ , where "r" denotes the minimized risk and "e" denotes the expected portfolio return after the problem is solved. Use successive

**Northeastern University**  
**ALY-6050**

values of 10%, 10.5%, 11%, 11.5%, 12%, 12.5%, 13% and 13.5% as the baseline return values to obtain eight pairs of solutions ( $r$ ,  $e$ ). Plot " $e$ " versus " $r$ ". Explain whether there exists a pattern in this plot. In other words, explain, in your opinion, the type of mathematical relationship that " $r$ " and " $e$ " may have.

**Northeastern University**  
**ALY-6050**

**ALY 6050 Rubric Project 6**

<b>Category Score</b>	<b>Characteristics</b>
<b>A Range</b> <i>Excellent</i> <b>145 –160 points</b>	<ul style="list-style-type: none"> <li>● <b>R/Excel</b> Accurate completion of 90%–100% of all R/Excel requirements. Code and/or excel is well formatted and easily readable.</li> <li>● <b>Report (Content)</b> Complete presentation and analysis of key results. Contains all required tables, and visualizations. Provides a precise description of the analytical concepts and theories used in the analysis.</li> <li>● <b>Report (Style and Submission)</b> Title page, introduction and conclusion/recommendation included; accurate APA citations; minor grammar or spelling errors; page numbers.</li> </ul>
<b>B Range</b> <i>Good</i> <b>120 - 145 points</b>	<ul style="list-style-type: none"> <li>● <b>R/Excel.</b> Accurate completion of 80%–90% of all requirements. Code and/or Excel is poorly formatted or difficult to read.</li> <li>● <b>Report (Content)</b> At most one major required component missing. Report shows gaps in reasoning or conclusions not supported by the data.</li> <li>● <b>Report (Style and Submission)</b> Missing one of the required elements (introduction, conclusion, etc.); incomplete or incorrect citations; occasional grammar or spelling errors. Imprecise.</li> </ul>
<b>C Range</b> <i>Satisfactory</i> <b>100 – 120 points</b>	<ul style="list-style-type: none"> <li>● <b>R/Excel.</b> Accurate completion of 70%–80% of all requirements. Major deficiencies in readability.</li> <li>● <b>Report (Content)</b> Report missing major required elements; evidence for recommendations is unclear or inaccurate; lack of organization.</li> <li>● <b>Report (Style and Submission)</b> Missing more than one of the required elements; few or no citations; frequent grammatical and spelling mistakes.</li> </ul>
<b>F Range</b> <i>Unsatisfactory</i> <b>0–100 points</b>	<ul style="list-style-type: none"> <li>● <b>R/Excel.</b> Accurate completion of fewer than 70% of all requirements. Disorganized and incomplete code.</li> <li>● <b>Report (Content)</b> Mostly missing.</li> <li>● <b>Report (Style and Submission)</b> Missing most required elements; major formatting or grammatical errors.</li> </ul>

Table 7: Project 6 Rubric