OM 352, Fall 2023 **HW 8** **Assigned: 9 Nov. 2023**
Due: 11:59 PM, 22 Nov. 2023

Instructions: Each assignment will include a PDF file (like this one) with the assignment questions and an Excel file, with an Answers sheet and any data or models that we provide you with. You must download both the PDF and Excel files. You have to enter your answers in the Answers sheet of the same Excel file you have downloaded, then save and upload the Excel file. You must upload the same Excel file you downloaded. Further instructions are provided in the Online Assignment Tools Guide (see **Assignments** in eClass).

Put your answers in the appropriate cells (salmon-colored cells) in the **Answers** sheet. Use paste special … values to for all numerical answers. The other cells in the Answers sheet are locked, which means you won't be able to enter values into those cells. Do not change the format of cells in the Answers sheet. Save your file with the appropriate name and in the appropriate format ("HW#_ID.xlsx").

Marking will be based on the answers in the Answers worksheet of the file you upload. We will only look at the rest of the file if there is an appeal (and even then, the answers in the Answers sheet take precedence.) If you wish to appeal a mark, then the file you uploaded must include your supporting work for each question. It is a good idea to make one worksheet for each question.

Total points: 18, of which 2 points are for following the submission instructions provided above.

Distribution Planning for Red Dog Beer, Part 2: The following is repeated from HW 7, for your reference.

The Red Dog case describes the situation as it was long time ago. Since then, the following has happened:

- Red Dog sold its current Calgary facility.
- The company opened a new facility in Edmonton. The annualized capital and operating cost of this facility is $1,000,000 per year, it is capable of producing up to 5,000 truckloads of beer per year, and the variable production cost is $750 per truckload. These values are higher than the values given in the case because of inflation and because of changes in the design of the facility.
- The proposed new facilities in Calgary, Red Deer and Lethbridge are no longer being considered.
- Demand per capita has changed, to an average of 1.1 truckloads per 1,000 people. The population has increased considerably.
- The transportation cost has increased to $2.5 per truck per km. This cost applies both for the trip from Edmonton to a demand location and the return trip from the demand location to Edmonton. Assume that that the truck follows the same route for the trip to the demand location and for the return trip.

The "Red Dog" worksheet has the list of all nodes and all arcs for answering the following question. Note that arcs have been duplicated to allow flow in both directions.

To answer the following questions, assume the following:

- Go back to the time when Red Dog has built no new facility yet and is still considering all four possible locations: **Edmonton, Calgary, Red Deer and Lethbridge**. This means that we ignored that a facility was built in Edmonton from HW7.
- The new facilities have the following characteristics:

	Edmonton	Red Deer	Calgary	Lethbridge
Annualized capital and operating cost (per year)	$1,000,000	$560,000	$900,000	$480,000
Production capacity (truckloads per year)	5,000	1,000	2,500	750
Variable production cost (per truckload)	$750	$450	$700	$650

- Everything else, including the transportation cost per km and demand per capita, remain as before.

In the questions below, when we ask you to "report all costs," that means report the annualized capital and operating cost, the annual production cost, the annual transport cost, and the annual total cost.

Hint: You can use the model for Question 6 from HW 7 as a starting point for this assignment.

1. (3 pts. for feasibility, 3 pts. for consistency, 2 pts. for optimality) As a benchmark, suppose that all four (4) new facilities are opened. Find the production and distribution plan that minimizes the total cost. Report how much to produce at each facility, report the number of truckloads shipped along the arcs in the network (list only arcs with non-zero shipments), and report all costs.

Note: This benchmark provides an upper bound on the optimal total cost that you will find in Question 2.

2. (3 pts. for feasibility, 3 pts. for consistency, 2 pts. for optimality) Now find the lowest-total-cost production plan by determining which of the new facilities should be opened in order to minimize the total cost. The decision to open a new facility should be binary, that is, either you open a new facility completely or not open it at all. Report which new facilities should be opened, report how much to produce at each facility, report the number of truckloads shipped along the arcs in the network (list only arcs with non-zero shipments), and report all costs.

Hint: Your solver model for Question 2 should be like the "Oil Extra" model, including the binary constraints.