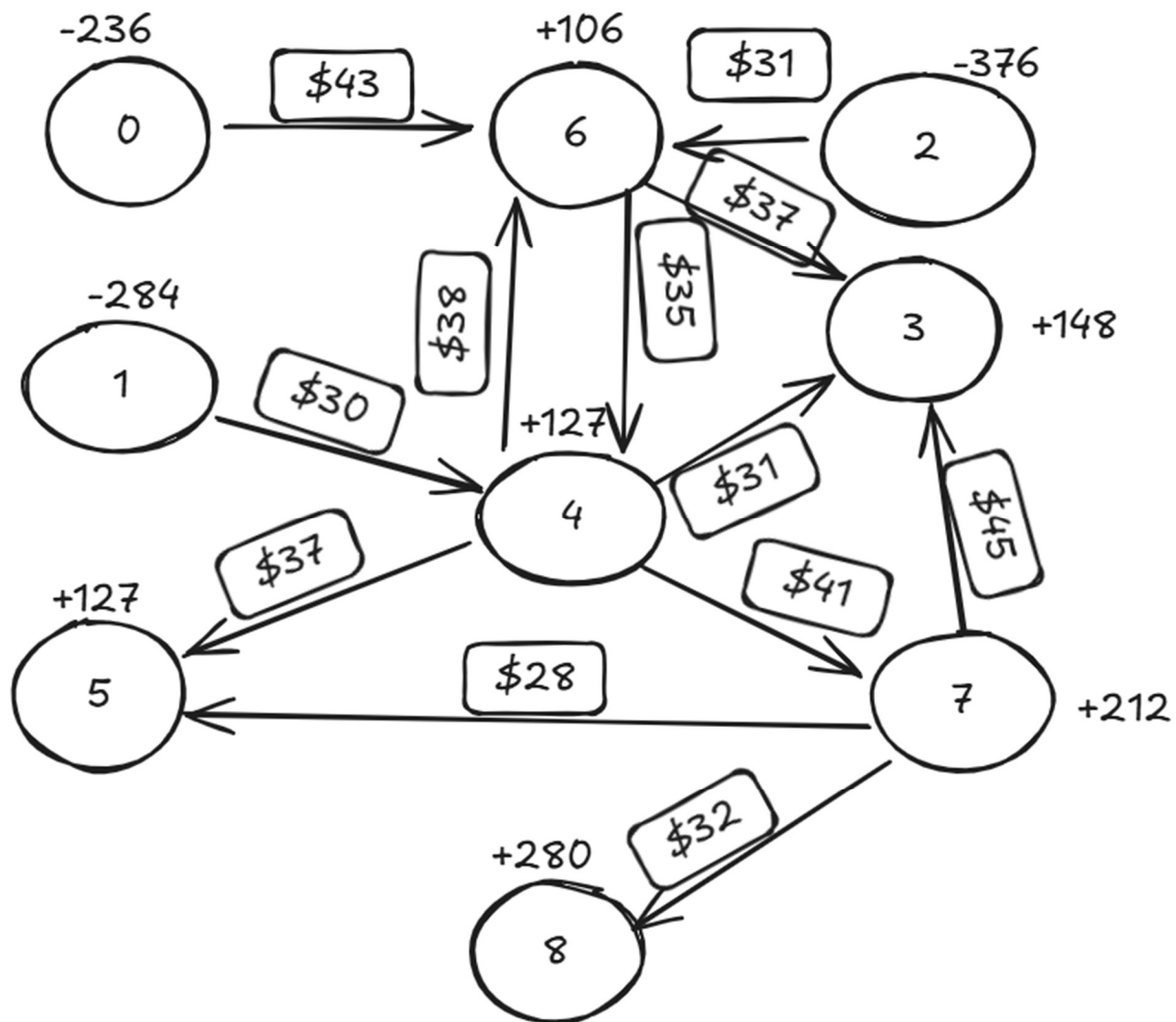# Module 06 – Transshipment Problem

Exploratory Data Analysis

In this section, you should perform some data analysis on the data provided to you. Please format your findings in a visually pleasing way and please be sure to include these cuts:
- *Make a visual graph of your data like what we saw for the sample problem*
  - https://excalidraw.com
  - https://mermaid.live
  - https://dreampuf.github.io/GraphvizOnline
  - Powerpoint

Model Formulation
Write the formulation of the model into here prior to implementing it in your Excel model. Be explicit with the definition of the decision variables, objective function, and constraints. Hint: This one differs a bit from the sample problem in terms of Balance-of-Flow

Min:
$$43X_{06}+30X_{14}+31X_{26}+31X_{43}+37X_{45}+38X_{46}+41X_{47}+37X_{63}+35X_{64}+45X_{73}+28X_{75}+32X_{78}$$

Constraints:

$-X_{06} >= -236$	**Node 0**
$-X_{14} >= -284$	**Node 1**
$-X_{26} >= -376$	**Node 2**
$X_{43}+X_{63}+X_{73} >= 148$	**Node 3**
$-X_{46}-X_{43}-X_{47}-X_{45}+X_{64}+X_{14} >= 127$	**Node 4**
$X_{45}+X_{75} >= 127$	**Node 5**
$-X_{63}-X_{64}+X_{06}+X_{46}+X_{26} >= 106$	**Node 6**
$-X_{73}-X_{75}+X_{78}+X_{47} >= 212$	**Node 7**
$X_{78} >= 280$	**Node 8**

Model Optimized for Minimal Transportation Cost
*Implement your formulation into Excel and be sure to make it neat. This section should include:*

- *A screenshot of your optimized final model (formatted nicely, of course)*

Total Transportation Cost -> $ 74,569.00

Ship	From		To		Unit Cost		Nodes		Inflow	Outflow	Net Flow	Supply/Demand
236	0	Butter Pecan Bluff	6	Melty Mint Mountains	$ 43		0	Butter Pecan Bluff	0	236	-236	-236
284	1	Candy Button Bay	4	Coconut Cream Cove	$ 30		1	Candy Button Bay	0	284	-284	-284
376	2	Chewy Cherry Chews Channel	6	Melty Mint Mountains	$ 31		2	Chewy Cherry Chews Channel	0	376	-376	-376
0	4	Coconut Cream Cove	3	Cinnamon Swamp	$ 31		3	Cinnamon Swamp	148	0	148	148
127	4	Coconut Cream Cove	5	Maple Fudge Forest	$ 37		4	Coconut Cream Cove	642	515	127	127
0	4	Coconut Cream Cove	6	Melty Mint Mountains	$ 38		5	Maple Fudge Forest	127	0	127	127
388	4	Coconut Cream Cove	7	Sprinkle Street	$ 41		6	Melty Mint Mountains	612	506	106	106
148	6	Melty Mint Mountains	3	Cinnamon Swamp	$ 37		7	Sprinkle Street	388	176	212	212
358	6	Melty Mint Mountains	4	Coconut Cream Cove	$ 35		8	Vanilla Valley	176	0	176	280
0	7	Sprinkle Street	3	Cinnamon Swamp	$ 45							
0	7	Sprinkle Street	5	Maple Fudge Forest	$ 28							
176	7	Sprinkle Street	8	Vanilla Valley	$ 32							

- *A text explanation of what your model is recommending*
  My model suggests that we ship out of every location except from 4 to 6, from 7 to 3, and from7 to 5. The rest of the destinations ship almost all of the materials from one destination to the other.

- *Update your graph from the EDA section to bold/color the links being used (and show how much is going through that link)*

-236
0
+106
6
$43
$31
-376
2
$37
$35
$38
-284
1
$30
3
+148
+127
$31
4
$37
+127
5
$41
$45
$28
7
+212
$32
+280
8
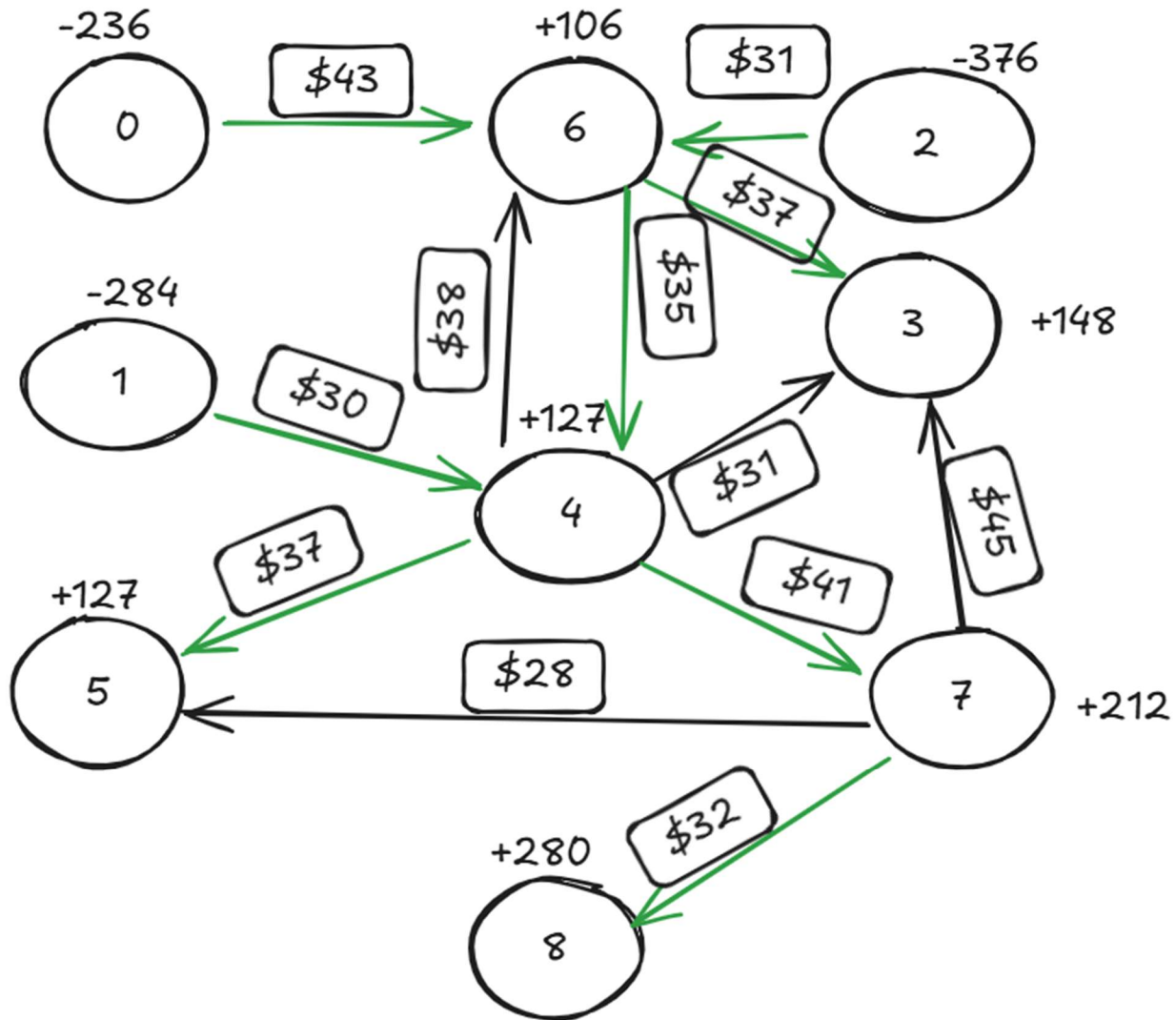
Model with Stipulation

Please copy the tab of your original model before continuing with the next part to avoid messing up your original solution.

Follow these steps to complete this section:

1. *Describe the necessity of the Balance-of-Flow for this problem type*
   Because of the balance of flow rules, you need to change the constraints from less than or equal to, to greater than or equal to. This is because you have more supply than demand.
2. *What happens when you change your model to make Total Supply > Total Demand (i.e. add 115 units to one of the sources)*
   There is no solution
3. *What happens when you rerun your model?*
   There is an error.
4. *What do you need to change to make your model work again?*

You need to change the contrariant from <= to >= in order for the model to work again. This is because you get more supply than you have demand, so you can satisfy all demand and have supply left over.

5. *Make the changes and report on your findings.*
   a. *PS there is a small chance that the source you added 115 to may make your model infeasible. If so, add the 115 units to a different source.*

When I made the changes, My minimum cost increased from $74,569.00 to $90,273.00. This was a $15,704 increase in cost.