Study Guide for the Final Exam

ISE 754: Logistics Engineering Fall 2019

Final Exam: Fri, 13 Nov, 8:00–11:00 a.m. in DAN 327, open notes and non-programmable calculator, closed computer. Keep in mind that you will not have access to Matlab during the exam, so you should be able to solve small, by-hand versions of the problems covered in class using a calculator. The exam will consist of (a) questions related to material not covered in Exams 1 and 2, including Warehousing and earlier material not suitable for the take-home format of Exams 1 and 2; and (b) questions related to the problems on Exams 1 and 2 that can include (i) solving a small instance of the problem that can be solved with a calculator, (ii) justifying the posted solution approach, and (iii) possible extensions of the problems. The exam will not include any material related to coding in Matlab/Matlog or the use of Supply Chain Guru.

To prepare for the exam, study the following: (a) homework assignments 2–8, especially any problems you solved by hand; (b) the posted solutions for the Exams 1 and 2; (c) be able to apply by hand the key algorithmic procedures implemented in Matlog to small problem instances (key procedures include *ala*, *ufladd*, *ufldrop*, *pmedian*, *dijk*, *rteTC*, *pairwisesavings*, *vrpsavings*, *twoopt*, *mincostinsert*, and *minTLC*); and (d) the following additional study problems:

1. The table below contains the variable costs associated with serving four EFs from a NF located at one of four sites. If the fixed cost of locating a NF at any site is 4, determine the number and location of NFs using the *UFLDROP* procedure. (*Answer*: Two NFs at sites 1 and 2, with a total cost of 19.)

NF\EF	1	2	3	4
1	3	7	5	1
2	5	6	1	4
3	1	10	4	8
4	3	5	8	7

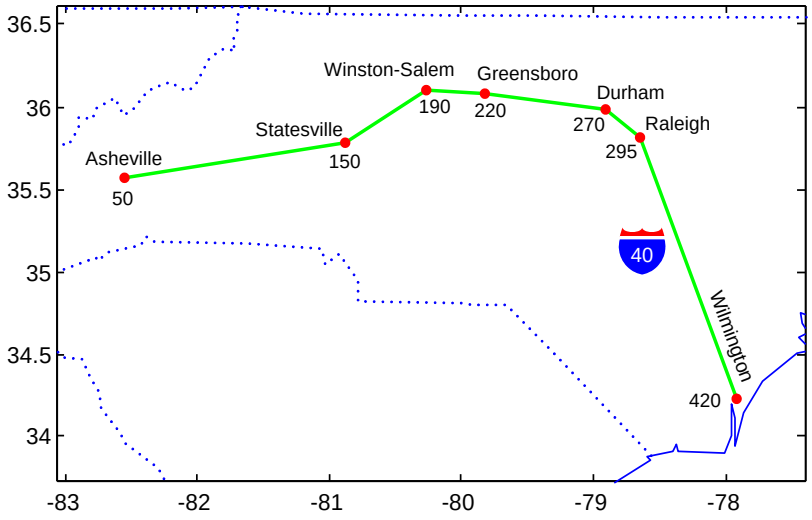
2. Use the great circle formula to determine the distance, in miles, between Raleigh, NC (35:49:19 N, 78:39:32 W) and Rio de Janeiro, Brazil (22:57 S, 43:12 W). (*Answer*: 4,679 miles.)

3. What is the difference in the transport charge to ship 5,000 lb of a Class 110 product LTL sometime during 2004 from Raleigh to Gainesville, FL using the undiscounted tariff given in the notes as compared to using the LTL rate estimation formula? (*Answer*: $1,802 using tariff vs. $1,199.50 using the formula, where 104.2 is the PPI_{LTL} for 2004.)

4. It is expected that 2.5 million cubic feet of product weighing 30 million pounds will be shipped each year from your DC to six customers located in Raleigh, NC (35:49 N, 78:39 W), Houston, TX (29:46 N, 95:23 W), Memphis, TN (35:06 N, 90:00 W), Due West, SC (34:20 N, 82:23 W), Warren, MI (42:29 N, 83:01 W), and Gainesville, FL (29:40 N, 82:20 W), with each customer receiving 15, 20, 25, 20, 15, and 5 percent of the total demand, respectively. Full P2P truckloads will be shipped to each customer, each truck's cubic and weight capacity is 2,750 ft^3 and 25 tons, respectively, and the TL revenue per loaded mile has not yet been

determined. Assuming that all distances are rectilinear, where should the DC be located in order to minimize transportation costs?
(*Answer*: DC at (35:06N, 83:01W))

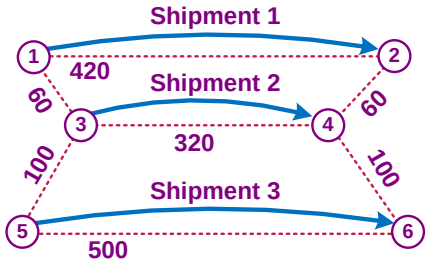
5. Why is the arc list representation preferred to the adjacency matrix representation if there are multiple connections between nodes in a logistics network?
6. Why does the per-unit cost of carrying inventory usually increase at each stage in a multi-stage production-inventory flow network, while it remains constant across each period in a stage?
7. In a multi-period production-inventory flow network, why is it incorrect to include the cost of carrying both the initial and final inventory in the total inventory cost calculation?
8. With respect to Question 5 of HW 7:
   (a) Why was production cost separated into variable and fixed components in the model?
   (b) How was the fact that only 30 tons of product can be stored at each statge included in the model?
   (c) Using some different data (as noted below, otherwise use the data given in HW 7) and only a three-month planning horizon, determine the total production, inventory, and transport cost over the horizon. The forecasted demand is 22, 30, and 33 tons per month. The product loses five percent of its value after one month. Each month, 20, 4, 40 and 25, 0, 37 tons, respectively, are produced at each stage. (*Answer*: $62,400 variable cost, $828.33 inventory, and $39,000 fixed cost, for a total cost of $102,228.33.)
9. When constructing a solution to the VRP using a pairwise-savings-based procedure, how is it possible that a customer may not be included in any of the routes constructed?



10. Given four shipments from Winston-Salem to Greensboro, Asheville to Durham, Statesville to Wilmington, and Winston-Salem to Raleigh (see figure above, where miles from beginning of I-40 in NC to each city is shown below its name) and assuming the transport rate for TL is $1 per mile and that there is sufficient capacity on a truck to carry all four shipments, determine

the allocated transport charge for each shipment would be under equal charge, equal savings, and Shapley allocation. (*Answer*: equal charge, all $92.50; equal savings, –33.75, 156.25, 206.25, 41.25, for shipments 1–4, respectively; Shapley, 7.50, 144.17, 181.67, 36.67)

11. Given the shipments shown in the figure below (showing distances in miles) and assuming the transport rate for TL is $1 per mile and that there is sufficient capacity on a truck to carry all three shipments, determine the allocated transport charge for each shipment would be under equal charge, equal savings, and Shapley allocation. (*Answer*: equal charge, all $246.67; equal savings, 253.33, 153.33, 333.33, for shipments 1–3, respectively; Shapley, 273.33,113.33,353.33)



12. A new shoe warehouse is being designed. A total of 120 different men and women shoe styles will be stored in warehouse, and each style is available in three different colors and ten different sizes. At its peak during the year, the warehouse will hold 2.4 million pairs of shoes. Randomized block stacking will be used to store 36 × 36 × 36 in. pallet loads of shoe cartons, one pair per carton. Each pallet can be used to store 24 cartons of the same SKU. The pallets can be stacked five-high along 10-foot-wide down aisles. Determine the minimum total 2-D area need for the warehouse assuming that the additional space needed for cross aisles, offices, and shipping/receiving docks will equal 20% of the total storage area. (*Answer*: 410,652 ft^2)

13. What is the change in the minimum expected total distance traveled along an eight-foot-wide down aisle for single-command S/R operations if four-high dedicated, as compared to randomized, block stacking of 42 × 36 in. two-way pallet loads of products A, B, and C is used? The area used for randomized storage maximizes 2-D cube utilization and the same storage depth is used for dedicated storage. All of the products are stored on one side of the aisle, and the opposite side of the aisle is used to store other products. The maximum inventory levels of the products are 120, 60, and 240, respectively, the levels are uncorrelated and retrievals occur at a constant rate, the products have throughput requirements of 30, 60, and 20, respectively, and the I/O port is located at the end of the aisle. (*Answer*: 540 ft increase (3090 ft dedicated, 3630 ft randomized))

14. A new warehouse is being designed to store 3,000 different SKUs. At its peak during the year, the warehouse will hold 50,000 loads. Randomized block stacking will be used to store 36 × 36 × 36 in. pallet loads and all of the slots in the warehouse are equally likely to be used. The pallets can be stacked six-high along 8-foot-wide down aisles. The warehouse will have a rectangular shape with a single I/O point located along its perimeter.

(a) Determine the minimum total 2-D area need for the warehouse assuming that the area required for cross aisles, offices, and shipping/receiving docks equals 15% of the total storage area. (*Answer*: 188,146 ft^2)

(b) Narrow-aisle reach trucks (NARs) will be used for all storage and retrieval operations. Loading or unloading each will require 30 seconds. Assuming all of the S/R operations are single command, determine the expected time required for each operation. (*Answer*: 2.00 min/mov)

15. With respect to the expected distance results for regions A and B covered in class, determine a simplified expression for d_A for the case where $TA_A \geq TA_{A+B}/2$. You can assume that $X = Y$ and $X_B = Y_B$. (*Answer*: $d_A = \frac{4}{3}\frac{X^3 + 3X^2X_B - X_B^3}{X^2 + 2XX_B - X_B^2}$)

16. A 2-D rectangular region with an I/O point in the middle of one side is used to store items A–D using a dedicated storage policy. The items require 300, 800, 300, and 600 ft^2 of storage area (including aisle space), respectively, and have weekly throughput requirements of 90, 320, 60, and 300, respectively. For each item, determine the expected distance traveled for each single-command S/R operation. (*Answer*: 84.27, 63.25, 103.40, and 32.66 ft for A–D, respectively)

17. Determine the cube per order and cube movement for the following item master and order dataset: (*Answer*: Cube per order = 2540 and cube movement = 1260, 384, 5400, and 576 for A–D)

SKU	Length	Width	Depth	Cube	Weight
A	5	3	4	60	7.45
B	6	4	5	48	8.05
C	8	6	5	180	12.50
D	4	4	3	32	9.75

Order	SKU	Qty	UOM	Order	SKU	Qty	UOM
1	A	3	EA	2	C	12	EA
1	B	4	EA	2	D	6	EA
1	C	6	EA	3	A	6	EA
2	A	12	EA	3	C	12	EA
2	B	4	EA	3	D	12	EA

18. Determine the demand correlation distribution for the four SKUs in the following order dataset: (*Answer*: A-B,C,D = 0.2,0.5,0.1, B-C,D = 0.3,0.2, C-D = 0.2)

Order	SKU	Order	SKU	Order	SKU	Order	SKU
1	A	2	C	5	A	7	D
1	B	2	D	5	C	8	A
1	C	3	A	6	D	9	A
2	A	3	C	7	B	9	C
2	B	4	D	7	C	10	D

Selected Answers

5. The adjacency matrix cannot represent multiple arcs between a pair of nodes because only a single number is used to represent the value in the matrix.

6. It increases at each stage in the network because each stage usually adds value to the product, while the decrease in value associated with carrying inventory for a period is usually the same for each period.

7. Since the network model is run for each period as part of a rolling horizon, including both the initial and the final inventory cost in the total cost would double count the inventory cost.

8(a). So that the economies of scale associated with production at each stage could be included in the model (an alternate approach would be to use a piecewise linear approximation to the concave production costs).

8(b). The storage constraint is included in the model as an upper bound on the amount of inventory carried across an arc.

9. There may be no savings associated combining pairs of customers; for example, each customer may have non-overlapping time windows that make a single combined route with both not feasible.