Study Guide for the Final Exam

ISE 754: Logistics Engineering Fall 2024

Final Exam: Wed, 11 Dec, 8:30–11:00 a.m. in 136 MRC, open notes and non-programmable calculator, closed computer. Remember that you will not have access to Julia 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 suitable for the take-home format of Exams 1 and 2; (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; and (c) material covered after Exam 2, namely, Inventory. The exam will not include any material related to coding in Julia or any of the reference materials or materials on reserve at the library.

To prepare for the exam, study the following: (a) homework assignments 2–9, especially any problems you solved by hand; (b) the posted solutions for Exams 1 and 2; (c) be able to apply by hand the key algorithmic procedures implemented in Julia to small problem instances (key procedures include *ala*, *ufladd*, *ufldrop*, *dijkstra*, *pairwisesavings*, *Clark-Wright savings*, *twoopt*, and *mincostinsert*; and (d) the following additional study problems:

1. The table below contains the variable costs associated with serving four EFs from an NF located at one of four sites. If the fixed cost of locating an 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

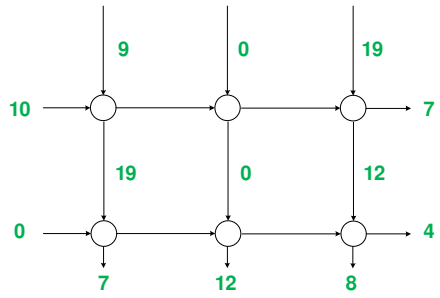
2. In HW4-Q2(b), why was it necessary to use several different starting points to find your solution?

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. Determine the missing inventory flows in the multi-period production-inventory flow network shown below.



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 Problem 1 of Exam 2:

   (a) Why was production cost separated into variable and fixed components in the model?

   (b) How was the fact that two identical machines were available at each stage included in the model?

   (c) Using some different data (as noted below, otherwise, use the data given in Problem 1) and only a three-week planning horizon and no scheduled maintenance, determine the total production, inventory, and transport cost over the horizon. The forecasted demand is 7, 12, and 8 tons per week. The product loses seven percent of its value after three weeks. Each week, 9, 0, 19 and 19, 0, 12 tons, respectively, are produced at each stage. (*Answer*: \$30,400 variable cost, \$623.32 inventory, and \$15,000 fixed cost, for a total cost of \$46,023.32.)

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. A new vaccine fulfillment center has been established that has the capacity to serve two customers. The dispensing and sterile packaging equipment can only fill one common-size container per customer because the set-up time to change the container size is very time-consuming. A single 235-unit container will be used for each customer's demand; any demand beyond the container capacity will be lost. The revenue received per unit of demand is \$5, and the cost to provide each unit is \$1. Once opened, each container must be used over a short period of time, and since the customers are dispersed geographically, it is not possible for them to share the vaccine. Determine the total profit given demands of 247 and 214 units per customer. (*Answer*: \$1,775.)

11. A single product is produced in a two-stage production process. Stage one has a capacity to produce 40 tons of the product per month, and there is a fixed cost of $6000 per month and a variable cost of $200 for each ton of product produced. For stage two, capacity is 80 tons per month, and there is a fixed cost of $18,000 and a variable cost of $800. The fixed costs are only incurred when any amount of production occurs at that stage for that month. Assuming that the annual inventory carrying rate is 0.4 $/$-yr, determine the inventory cost for each stage. (*Answer*: $11.67 for stage one and $45.83 for stage two.)

12. Each month, it takes three days for a full truckload of components with a density of 12 lb/ft^3 to travel from a supplier in Tacoma, OR, to a facility in Due West, SC. What is the average in-transit inventory of components (in tons), assuming cubic and weight capacities are 2,750 ft^3 and 25 tons, respectively? (*Answer*: 1.6263 ton.)

13. With respect to the multiple regression model used in the example of the notebook *Inv 1*, how many loaves should be baked for day 14 if 145 loaves have been ordered by the morning of day 14 and there have been 80 unique visitors to the website? (*Answer*: 320.)

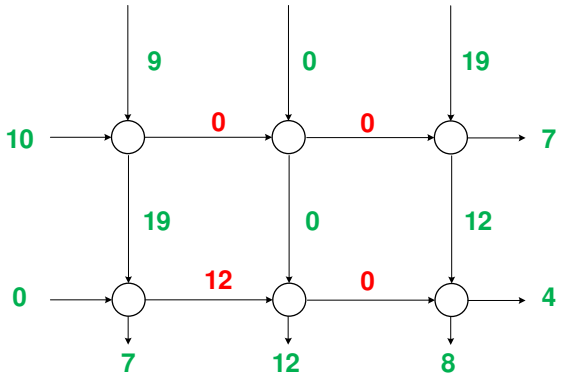
14. Explain why determining the optimal safety stock requires maximizing total profit while determining the optimal working and economic stock requires minimizing total cost.

15. With respect to the optimal order point policy for a given set of parameters, if there is a decrease in the fixed cost per order and everything else stays the same, explain why the probability of being out of stock would either likely increase or decrease.

Selected Answers

2. Only a locally optimal solution was found from each starting point, so several different starting points were used, and the best solution was reported.

5.



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). A constraint is included in the model as an upper bound on the number of integer-valued machines.

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

14. Safety inventory is carried to avoid stocking out, and the impact of stocking out is the loss in profit due to a lost sale. Determining the optimal level of safety stock requires balancing the loss of profit with the cost of carrying the inventory. Working and economic stock involves trading off the cost of carrying the inventory with other costs associated with providing the inventory, like, for example, the cost of transporting the inventory. Determining the optimal level of these inventories requires balancing both of these costs.

15. Decrease because the decrease in ordering cost would allow more frequent ordering, making it less likely to stock out.