IE375 Fall 2020 Exercise Set # IVa

This set it additional to Exercise Set # IV which contains Questions on Chapter 5. Most of the below are exam questions. Some of them are "cleaner" version of problems you will encounter in real-life – solving them and/or understanding them is a rewarding challenge.

1) Question from Chapter 5 of your textbook, 7th Edition, p. 302 – Problem 45 (6th Edition, p. 299 – Problem 45) – A reasonable application of discrete demand distributions.

2) Consider a single perishable-item production system with the following characteristics:

- The variability in the demand process is neglected and demand is assumed to be constant with known fixed rate, λ units per year.
- The parameters of interest are specified as the unit production cost ($c per unit), fixed setup cost ($K per setup), finite production rate capability (P units per year, $P > \lambda$)
- The inventory carrying charge is charged only to the maximum finished goods inventory level reached in the system. Let $h be charged per unit (of the maximum inventory level) per year. (There might several reasons for charging only the peak inventory level. In this case, assume that a bank controls the production system and is only interested in the maximum value of inventory, as it will determine the size of credit that will be given to the firm.)

Answer the following questions:

a) Assume that excess demand is not allowed and there is no restriction on the lot size.

i. Formulate the above problem to determine the optimal production lot size that minimizes the average cost function - sum of average setup, production and holding costs. (Hint: You must determine the maximum inventory level, as a function of lot size, Q.)

ii. Determine the optimal lot size.

b) The item has a limited shelf life of L years, and you are asked to consider that in your decision. Describe how you will determine the optimal lot size in this case? (Hint: The last item produced is expected to stay in the inventory at most L years before demand arrives.)

3) Consider a firm stocking n items for resale. For each item a (Q,R) continuous inventory policy is followed. The following information is supplied for each item: unit cost (c_i), expected lead time demand (x_{Li}), lead time demand distribution ($f_i(x_i)$) and cost per unit short (b_i). Moreover, you are given the information that ordering quantities (i.e., Q_i's) are predetermined by management.

a. Write an expression for the expected total cost of stock-out for a single-item. Now write it for all items.

b. Formulate the problem where you minimize expected total cost of stock-outs subject to a constraint on expected total value of the reorder levels, i.e., expected lead time demand + safety stock.

c. Try to outline a method to solve the above problem.

4) The Lit-engine Company manufactures piston engines for ultra-light aircraft. The company considers making a last production run of an older-model engine that is going to be eliminated within the near future. The unit production cost is $c and sells for $p per unit. The junkyard pays Lit engine a salvage value of $s for each unit unsold and there is a goodwill loss of $b per unit short.

The demand pattern for the engine is exponential, with probability density function of

$$f(d) = \frac{1}{75} e^{-d/75} \quad d \geq 0.$$

a. Find the optimum production batch to maximize expected profit.

b. Give the expression for expected number of unsold engines when you choose the optimum production batch.

5) A company faces a fixed rate of demand for a particular item with $\lambda = 600$ units per year. The company can either produce or outsource the item. If the company decides to produce the item, a fixed cost of $8000 must be paid to setup the current machine and each item costs $5. In this option, the company can produce at most 1500 units per year. If the company decides to outsource the item, a fixed ordering cost of $K must be paid per order; however, the unit cost is $6. There is no limit on the number of units to outsource. Backorders and/or lost sales are not allowed. Holding cost is based on I=20%annual interest rate, i.e., h=I*c; Hence, h will change if the item is manufactured or outsourced.

a) Step by step describe how you would answer the following question: Should the company produce or outsource? At each step, if you are using a formula, write the formula and explain what the value of each term in the formula is explicitly.

b) State the K (fixed ordering cost, if outsourced) value for which the company will be indifferent to produce or outsource.

c) Write the average total cost for the following problem if you can have a combination of production and outsourcing: Let Q_1 define the quantity to outsource at every cycle and Q_2 the quantity to produce. Assume that you in a cycle you first receive the amount outsourced. Then, when inventory goes to zero you start producing in-house. When you produce Q_2 units, you stop production, wait for the inventory to deplete. When you hit zero, the outsourced amount comes. Assume lead-times to be zero.