MSING053 – Operations Analytics
Individual Assignment substituting Quiz 2
Due Date: 10 am 07 April

Section A - Multiple Choice Questions (15 marks)

1. (5 marks) In IA 2 earthquake shelter problem, we formulate it using Integer Programming. For each location i, we set indicator decision variable x_i: $x_i=1$ if location i has a shelter, $x_i=0$ otherwise. We also set indicator decision variables y_i: $y_i=1$ if location i has at least one shelter within 1.5-mile distance; $y_i=0$ otherwise. We have two distant matrixes: D and E. $D_{ij}=1$ means location i is within 2 miles distance of loaction j, and $D_{ij}=0$ otherwise. $E_{ij}=1$ means location i is within 1.5 miles distance of loaction j, and $E_{ij}=0$ otherwise. Which of the following statements is **WRONG**?
   - **a.** If we want to maximize the total number of locations which have at least one shelter within 1.5 miles, the objective is: max $\sum_j y_j$.
   - **b.** The total number of shelters within 2 miles of location j is $\sum_i D_{ij} x_i$.
   - **c.** The total number of shelters within 1.5 miles of location k is $\sum_i E_{ik} x_i$.
   - **d.** If $\sum_i E_{ij} x_i > 1$, then $y_j=1$; otherwise, $y_j=0$.
   - **e.** A linear inequality to express the logic in d is $y_j \leq \sum_i E_{ij} x_i$.

2. Which of the following statements are **WRONG**?
   - **a.** At Littlefield Lab Station 2, where both steps 2 and 4 are processed, it is better to give priority to the shorter step than to the longer step.
   - **b.** Periodic Review Policy has fixed order quality whereas Continuous Review Policy has fixed reorder point.
   - **c.** In the Newsvendor Game, if the underage cost equals the overage cost, and the demand is Normal distributed, then the optimal order quantity is the mean.
   - **d.** Reducing the lead time, improving communication and data sharing in the supply chain would decrease the Bullwhip effect.
   - **e.** Under Continuous Review Policy, the objective is to minimize the sum of setup cost and inventory holding cost.

3. (5 marks) Which of the following statements about revenue management is **WRONG**?
   - **a.** Revenue management is widely used in travelling industry include airlines and hotels.
   - **b.** It is more profitable for a monopolist to set one single price than different prices at different markets.
   - **c.** The booking limit is the maximum number of seats sold to the low-end customers.
   - **d.** Capacity control is to trade off cannibalization cost and spoilage cost.
   - **e.** Overbooking is to trade off spoilage cost and denied board cost.

Section B - Problems (75 marks)

Questions 1-2 are based on this setting:
Raman starts a car rental store. When a customer comes to rent the car, s/he states the duration of the rental and pays £**60**/day for this duration upfront. If s/he returns the car after the deadline, Raman charges a penalty of £**100**/day for each day in excess of the deadline. Raman cuts a deal with a distant Auto dealership who are willing to rent him out cars at £**20**/day. He can only order once from the dealership.

1. (6 marks) Raman notes that all his customers seem to rent cars only for 1 day at a time and are never late. The daily demand is i.i.d. and has the following probability distribution. How many cars should Raman order from the dealership to maximize his profits? What is the stock-out probability?

Demand	Probability	Cumulative Distribution Function
0	0.10	0.10
10	0.28	0.38
20	0.26	0.64
30	0.20	0.84
60	0.16	1

2. (7 marks) Suppose you want to rent a car from Raman. You believe your requirement for the car to be discrete uniformly distributed between 1 to 4 days. That is, the probability of demand being 1, 2, 3, 4 days is 0.25 respectively. Suppose you contract for a rental duration that

ensures the lowest expected payment to Raman. What is the optimal rental duration should you contract? What is the expected payment?

3. (12 marks) CWC has designated ShirtCo (a shirt manufacturer) as its sole supplier for its summer signature shirt. Under the arrangement ShirtCo has agreed to deliver the entire order of shirts for £**16** per shirt. It costs ShirtCo £**10** to make a shirt. CWC sells shirts at its store at £**32** each. Suppose ShirtCo offers to buy back from CWC any unsold shirts at the end of the season at £**8** each. ShirtCo gets £**5** salvage value for each buy-back shirt. The probability of demand being 1000, 2000, 3000, 4000, 5000 is 0.2 respectively. What is the optimal order quantity of CWC? Under the optimal order quantity, what are the expected profits for CWC and ShirtCo respectively?

Questions 4-5 are based on this setting:
In the Littlefield setting, we assume the daily demand is Normal distribution with mean **20** and standard deviation **20**. The order lead time is **4** days. The raw material purchase price is **100** pounds per unit. The yearly interest rate is **10**%. The setup cost is **365** pounds. Assume the inventory holding cost is the financial interest cost. One year is **365** days. The manager chooses the z-value of safety stock as 2.

4. (11 marks) If the manager adopts Continuous Review Policy, what is the average inventory level and yearly inventory turns? What is yearly inventory related costs (setup costs+ inventory holding cost)?

5. (9 marks) Suppose the manager adopts Periodic Review Policy and use the order cycle of 18 day, what is the average inventory level and yearly inventory turns? What is yearly inventory related costs (setup costs+ inventory holding cost)?

6. (30 marks) **Open Discussion**

During the coronavirus outbreak in UK, you may have experienced empty shelves in many supermarkets due to consumer stockpiling behavior. Based on EOQ model, if the demand is constant, then increased order quantity leads to decreased order frequency, decreasing the level of personal contacts. However, many panic shoppers encounter stock-out and try to search their wanted items several times at multiple supermarkets, creating more shop visits and larger crowds. The empty shelves and long queues at checkout desks aggravate consumer panic and deteriorate the demand surge. Therefore, it is important for the supermarkets to keep up the service level and decrease stock-outs.

Competition law is relaxed on Thursday and supermarkets can share their data and resource.
https://www.gov.uk/government/news/supermarkets-to-join-forces-to-feed-the-nation
Specifically, the move allows retailers to share data with each other on stock levels, cooperate to keep shops open, or share distribution depots and delivery vans. It would also allow retailers to pool staff with one another to help meet demand.

Questions:

a. Use what you have leant from this module to discuss how the changed regulation can improve the supply chain, from the perspective of service level, bullwhip effect, resource pooling, etc.
b. What are your suggestions for the supermarkets to feed the nation? You need to justify your suggestions.