Q1.

Consider the following demand scenario:

Quantity	Probability
9,000	15%
11,000	18%
13,000	21%
15,000	25%
17,000	11%
19,000	10%

Suppose the manufacturer produces at a fixed cost of $150,000 and a variable cost of $63/unit. The manufacturer sells the products to the retailer at the wholesale price of $77/unit. The retailer sells to end customers for $115/unit. Unsold products will be sold to the discount store at the price of $22/unit after the season.

a. What is the supply chain's marginal profit and marginal loss?

b. Given that the order quantity is 15,000 units, what is the expected profit under global optimization?

(Note: Students are required to provide detailed calculation for the expected profit of D = 11,000 and D = 17,000. Profits of the remaining demands can be shown in a table.)

Suppose the manufacturer is make-to-order, the manufacturer and retailer have a supply contract, in which the manufacturer agrees to decrease the wholesale price from $77 to $65, and in return, the retailer provides 16 percent of the product revenue to the manufacturer.

c. What is this type of supply contract?

d. What is the retailer's marginal profit and marginal loss? What is the manufacturer's marginal profit?

e. Given that the order quantity is 15,000 units, what are the expected profit for the manufacturer and the retailer?

(Note: Students are required to provide detailed calculation for the expected profit of D = 11,000 and D = 17,000. Profits of the remaining demands can be shown in a table.)

$F = \$150{,}000;\ c = \$63;\ w = \$77;\ p = \$115;\ s = \$22$

a) What is the supply chain's marginal profit and marginal loss?

- $Supply\ chain's\ marginal\ profit = p - c = 115 - 63 = \mathbf{\$52}$
- $Supply\ chain's\ marginal\ loss = c - s = 63 - 22 = \mathbf{\$41}$

b) Given that the order quantity is 15,000 units, what is the expected profit under global optimization?

$Q \le D: Profit = Q \times SCMP - F$

$Q > D: Profit = D \times SCMP - F - (Q - D) \times SCML$

- $D = 11{,}000$:

$Profit = D \times SCMP - F - (Q - D) \times SCML$

$$= 11{,}000 \times 52 - 150000 - (15{,}000 - 11{,}000) \times 42 = \mathbf{\$258{,}000}$$

- $D = 17{,}000$:

$Profit = Q \times SCMP - F = 15{,}000 \times 52 - 150{,}000 = \$\mathbf{630{,}000}$

D (units)	Q	SC's Profit	E(SC's Profit)
9,000	15,000	$72,000	**$440,280**
11,000	15,000	$258,000	
13,000	15,000	$444,000	
15,000	15,000	$630,000	
17,000	15,000	$630,000	
19,000	15,000	$630,000	

c) What is this type of supply contract?

Revenue-sharing contract

d) What is the retailer's marginal profit and marginal loss? What is the manufacturer's marginal profit?

$w = \$65$

- $Retailer's\ marginal\ profit\ (RMP) = p - w = 115 - 65 = \$\mathbf{50}$
- $Retailer's\ marginal\ loss\ (RML) = w - s = 65 - 22 = \$\mathbf{43}$
- $Manufacturer's\ marginal\ profit\ (MMP) = w - c = 65 - 63 = \$\mathbf{2}$

e) Given that the order quantity is 15,000 units, what are the expected profit for the manufacturer and the retailer?

Retailer:

$Q \leq D: Profit = Q \times p \times (1 - 0.16) - Q \times w$

$Q > D: Profit = D \times p \times (1 - 0.16) - D \times w - (Q - D) \times RML$

- $D = 11{,}000$:

$$Profit = D \times p \times (1 - 0.16) - D \times w - (Q - D) \times RML$$
$$= 11{,}000 \times 115 \times (1 - 0.16) - 11{,}000 \times 65 - (15{,}000 - 11{,}000) \times 43$$
$$= \$\mathbf{175{,}600}$$

- $D = 17{,}000$:

$$Profit = Q \times p \times (1 - 0.16) - Q \times w = 15{,}000 \times 115 \times (1 - 0.16) - 15{,}000 \times 65$$
$$= \$\mathbf{474{,}000}$$

D (units)	Q	R's Profit	E(R's Profit)
9,000	15,000	$26,400	**$321,816**
11,000	15,000	$175,600	
13,000	15,000	$324,800	

15,000	15,000	$474,000	
17,000	15,000	$474,000	
19,000	15,000	$474,000	

Manufacturer:

$$Q \leq D: Profit = Q \times MMP + Q \times p \times 0.16 - F$$

$$Q > D: Profit = Q \times MMP + D \times p \times 0.16 - F$$

- $D = 11{,}000$:

$$Profit = Q \times MMP + D \times p \times 0.16 - F = 15{,}000 \times 2 + 11{,}000 \times 115 \times 0.16 - 150{,}000 = \mathbf{\$82{,}400}$$

- $D = 17{,}000$:

$$Profit = Q \times MMP + Q \times p \times 0.16 - F = 15{,}000 \times 2 + 15{,}000 \times 115 \times 0.16 - 150{,}000 = \mathbf{\$156{,}000}$$

D (units)	Q	M's Profit	E(M's Profit)
9,000	15,000	$45,600	**$118,464**
11,000	15,000	$82,400	
13,000	15,000	$119,200	
15,000	15,000	$156,000	
17,000	15,000	$156,000	
19,000	15,000	$156,000	

Q2.

Marriott is a company that sells copiers. Marriott currently sells 15 variants of a copier, with five distinct components: photoreceptor drum, corona cable, lamp, toner, and duplex. With the disaggregate option, Marriott must design specific components for each copier variant. Under the common-component option, Marriott designs variants such that three distinct photoreceptor drums, three distinct corona cables, three distinct lamps, three distinct toners, and three distinct duplexes can be combined to create 15 copier variants. Monthly demand for each of the 15 copier variants is independent and normally distributed, with a mean of 1,000 and a standard deviation of 200. The replenishment lead time for each component is two months. Marriott is targeting a customer service level of 95 percent for component inventory. Given that $F^{-1}(0.95) = 1.645$.

a. What is the total safety inventory required under disaggregate option?

b. What is the total safety inventory required under common-component option?

c. Which option should Marriott choose in order to reduce the safety inventory, disaggregate or common-component option? Why? If so, what is the percentage of safety inventory that was reduced by using that option?

a) What is the total safety inventory required under disaggregate option?

We first evaluate the disaggregate option, in which components are specific to a copier variant. For each component, we have:

- $Standard\ deviation\ of\ monthly\ demand\ =\ 200$

Given a lead time of two month and a total of 15 x 5 = 75 components across 15 copier variants, we obtain:

- $Total\ safety\ inventory\ required = 75 \times NORMSINV(0.95) \times \sqrt{2} \times 200 = \mathbf{34,896}\ units$

b) What is the total safety inventory required under common-component option?

In the case of component commonality, each component ends up in 5 finished products (15 copier variants divided by 3 types of photoreceptor drum/corona cable/lamp/toner/duplex). Therefore, the demand at the component level is the sum of demand across 5 products.

- $Safety\ inventory\ per\ common\ component = NORMSINV(0.95) \times \sqrt{2} \times \sqrt{5} \times 200 = 1{,}040\ (units)$

With component commonality, there are a total of 15 distinct components (3 distinct photoreceptor drums+ 3 distinct corona cables + 3 distinct lamps + 3 distinct toners + 3 distinct duplexes).

- $Total\ safety\ inventory\ required\ =\ 15 \times 1{,}040 = \mathbf{15,600}$

c) Which option should Marriott choose in order to reduce the safety inventory, disaggregate or common-component option? Why? If so, what is the percentage of safety inventory that was reduced by using that option?

Having each component common to 5 products results in a reduction in safety inventory for Marriott from 34,896 to 15,600 units. Thus, Marriott should choose common-component option in order to reduce the safety inventory.

$$Reduction\ percentage = \left(\frac{34{,}896 - 15{,}600}{34{,}896}\right) \times 100 = \mathbf{55.30\%}$$

Q3.

Orion is one of the biggest truck firms in Vietnam. Orion has a current capacity of 350,000 cubic feet. A large manufacturer is willing to purchase the entire capacity at \$0.20 per cubic foot per day. The manager at Orion has observed that on the spot market, trucking capacity sells for an average of \$0.29 per cubic foot per day. Demand, however, is not guaranteed at this price. The manager forecasts daily demand on the spot market to be exponentially distributed, with a mean of 82,600 cubic feet.

a. What are the unit overstocking cost and the unit understocking cost?

b. What are the probability of overstocking and the probability of understocking?

c. How much trucking capacity should the manager save for the spot market to maximize the expected revenue?

d. If the daily demand on the spot market is normally distributed, with a mean of 75,000 cubic feet and a standard deviation of 25,000, how much trucking capacity should the manager save for the spot market to maximize the expected revenue?

$p_F = \$0.29; p_D = \$0.20; D_F \sim Expo(\frac{1}{82{,}600}); D_D = \infty$

a) What are the unit overstocking cost and the unit understocking cost?

- $c_o = p_D = \mathbf{\$0.20}$
- $c_u = p_F - p_D = 0.29 - 0.20 = \mathbf{\$0.09}$

b) What are the probability of overstocking and the probability of understocking?

Let x be the trucking capacity saved for the spot market.

$$F(x^*) = \Pr(Y \le x^*) = \frac{c_u}{c_u + c_o} = \frac{0.09}{0.09 + 0.20} = \frac{9}{29} \approx \mathbf{31.03\%}$$

$$1 - F(x^*) = \Pr(Y \ge x^*) = \frac{c_o}{c_u + c_o} = \frac{0.20}{0.09 + 0.20} = \frac{20}{29} \approx \mathbf{68.97\%}$$

c) How much trucking capacity should the manager save for the spot market to max imize the expected revenue?

$$Exp(\lambda) = Exp\left(\frac{1}{\mu}\right) \to \lambda = \frac{1}{82{,}600}$$

$$F(x^*) = \Pr(Y \le x^*) = 1 - e^{-\lambda x^*}, \text{ with } x^* \ge 0$$

$$\to x^* = -\frac{1}{\lambda}\ln[1 - \Pr(Y \le x^*)] = -82{,}600 \times \ln\left(1 - \frac{9}{29}\right) = 30{,}691.15$$

$$\approx \mathbf{30{,}691}\ (cubic\ feet)$$

d) If the daily demand on the spot market is normally distributed, with a mean of 75 ,000 cubic feet and a standard deviation of 25,000, how much trucking capacity sh ould the manager save for the spot market to maximize the expected revenue?

$\mu = 75{,}000; \sigma = 25{,}000$

$$F(x^*) = \Pr(Y \le x^*) = 0.3103 \to z = -0.49$$

$$\to x^* = \mu + z\sigma = 75{,}000 - 0.49 \times 25{,}000 = \mathbf{62{,}750}\ (cubic\ feet)$$

Q4.

Helen Wu, vice president of supply chain at Michelle’s Hardware, was looking at the financial results from the past quarter and thought that the company could significantly improve its distribution costs.

Michelle’s had 32 stores in Indiana and sourced its products from eight suppliers located in the Midwest. The company began in Indiana and its stores in the state enjoyed strong sales. Each Indiana store sold, on average, 50,000 units a year of product from each supplier (for annual sales of 400,000 units per store). Given the large sales at its Indiana stores, Michelle’s followed a direct-ship model and shipped small truckloads (with a capacity of 10,000 units) from each supplier to each of its Indiana stores. Each small truck cost \$450 per delivery from a supplier to an Indiana store and could carry up to 10,000 units. Holding costs for Michelle’s were \$1 per unit per year.

Helen asked her staff to propose different distribution alternatives for Indiana. Helen’s staff proposed two alternative distribution strategies for the stores in Indiana:

- **Alternative 1:** Use direct shipping with even larger trucks that had a capacity of 40,000 units. These trucks charged only \$1,150 per delivery to an Indiana store. Using larger trucks would lower transportation costs but increase inventories because of the larger batch sizes.

- **Alternative 2:** Run milk runs from each supplier to multiple stores in Indiana to lower inventory cost even if the cost of transportation increased. Large trucks (capacity of 40,000 units) would charge $1,000 per shipment and a charge of $150 per delivery. Small trucks (capacity of 10,000 units) would charge $400 per shipment and a charge of $50 per delivery. Given that the suppliers run milk runs to ***four stores*** on each truck.

a. What is the annual distribution cost of the current distribution network? Include transportation and inventory costs.

b. How should Helen structure distribution from suppliers to the stores in Indiana, Alternative 1 or Alternative 2? What annual savings can she expect?

What changes in the distribution network (if any) would you suggest as the Indiana's market grows?

a) What is the annual distribution cost of the current distribution network? Include transportation and inventory costs. (5 points)

Batch size shipped from each supplier to each store: 10,000 units

Number of shipments per year from each supplier to each store: 50,000/10,000 = 5

Annual trucking cost for direct network: 5 x (0+450) x 8 x 32= $576,000

Average inventory at each store for each product: 10,000/2 = 5,000 units

Annual inventory cost for direct network: 5,000 x 1 x 8 x 32 = $1,280,000

Total annual cost of direct network: 576,000 + 1,280,000 = $1,856,000

b) How should Helen structure distribution from suppliers to the stores in Indiana, A lternative 1 or Alternative 2? What annual savings can she expect? (20 points)

Alternative 1:

- Batch size shipped from each supplier to each store: 40,000 units
- Number of shipments per year from each supplier to each store: 50,000/40,000 = 1.25
- Annual trucking cost for direct network: 1.25x (0+1,150) x 8 x 32= $368,000
- Average inventory at each store for each product: 40,000/2 = 20,000 units
- Annual inventory cost for direct network: 20,000 x 1 x 8 x 32 = $5,120,000
- Total annual cost of direct network: 368,000 + 5,120,000 = $5,488,000

Alternative 2 – Large Truck:

- Batch size shipped from each supplier to each store: 40,000/4 = 10,000 units
- Number of shipments per year from each supplier to each store: 50,000/10,000 = 5
- Cost per shipment per store (4 stores/truck): 1000/4+150 = $400
- Annual trucking cost for milk runs network: 5 x 400 x 8 x 32= $512,000
- Average inventory at each store for each product: 10,000/2 = 5,000 units
- Annual inventory cost for milk runs network: 5,000 x 1 x 8 x 32 = $1,280,000
- Total annual cost of milk runs network: 512,000 + 1,280,000 = $1,792,000

Alternative 2 – Small Truck:

- Batch size shipped from each supplier to each store: 10,000/4 = 2,500 units

- Number of shipments per year from each supplier to each store: 50,000/2,500 = 20
- Cost per shipment per store (4 stores/truck): 400/4+50 = $150
- Annual trucking cost for milk runs network: 20 x 150 x 8 x 32= $768,000
- Average inventory at each store for each product: 2,500/2 = 1,250 units
- Annual inventory cost for milk runs network: 1,250 x 1 x 8 x 32 = $320,000
- Total annual cost of milk runs network: 768,000 + 320,000 = $1,088,000

Because the total annual cost of Alternative 1 and Alternative 2 – Small Truck are higher than the total annual cost of current network, there is no saving cost for these cases.

The annual saving cost of Alternative 2 – Small Truck

= (Total annual cost of current network) – (Total annual cost of Alternative 2 – Small Truck) = 1,856,000 – 1,088,000 = $768,000

c) What changes in the distribution network (if any) would you suggest as the Indian a's market grows? (5 points)

Since the total annual cost of Alternative 2 – Small Truck (Milk runs with Small Truck) is the smallest one, Helen should change the current network into milk run network with small truck.

Q5.

Consider a retailer selling a single item. Based on past experience, management estimates the relationship between demand, D, and price, p, by the linear function D=2000-0.6p. The retailer is considering differential pricing strategies for different market segments.

a. At what price is revenue maximized? What is the total revenue if this price is applied?

b. If the retailer employs the two-tier pricing strategy, in which he introduces two prices (p1=$1,000 and p_2=$1,600), what is the total revenue?

c. If the retailer employs the three-tier pricing strategy (p_1=$1,000, p_2=$1,600 and p_3=$1,800), what is the total revenue?

d. Which strategy will include the highest total revenue? How much higher in $ and % of this strategy comparing with the other two policies?

(Requirement: Show step-by-step manual calculation for this problem)

a. At what price is revenue maximized? What is the total revenue if this price is applied?

Retailer's total revenue: $TR = pD$

$\Leftrightarrow TR = p(2000 - 0.6p) = 2000p - 0.6p^2$

- Take the first derivative of TR with respect to p:

$$\frac{\partial TR}{\partial p} = 2000 - 1.2p = 0 \Leftrightarrow p = \frac{5000}{3} = \$1{,}666.67$$

- The total revenue at this price:

$$TR = 2000p - 0.6p^2 = 2000 \times \frac{5000}{3} - 0.6 \times \left(\frac{5000}{3}\right)^2 = \$1{,}666{,}666.67$$

b. If the retailer employs the two-tier pricing strategy, in which he introduces two prices ($p_1 = \$1,000$ and $p_2 = \$1,600$), what is the total revenue?

- $p_1 = 1{,}000 \Rightarrow D_1 = 2{,}000 - 0.6 \times 1{,}000 = 1{,}400$
- $p_2 = 1{,}600 \Rightarrow D_2 = 2{,}000 - 0.6 \times 1{,}600 = 1{,}040$
- $TR_{two-tier} = p_2 D_2 + p_1(D_1 - D_2) = 1{,}600 \times 1{,}040 + 1{,}000 \times (1{,}400 - 1{,}040) = \$2{,}024{,}000$

c. If the retailer employs the three-tier pricing strategy ($\boldsymbol{p_1 = \$1,000, p_2 = \$1,600}$ and $\boldsymbol{p_3 = \$1,800}$), what is the total revenue?

- $p_1 = 1{,}000 \Rightarrow D_1 = 2{,}000 - 0.6 \times 1{,}000 = 1{,}400$
- $p_2 = 1{,}600 \Rightarrow D_2 = 2{,}000 - 0.6 \times 1{,}600 = 1{,}040$
- $p_3 = 1{,}800 \Rightarrow D_3 = 2{,}000 - 0.6 \times 1{,}800 = 920$
- $TR_{three-tier} = p_3 D_3 + p_3(D_2 - D_3) + p_1(D_1 - D_2) = 1{,}800 \times 920 + 1{,}600 \times (1{,}040 - 920) + 1000 \times (1{,}400 - 1{,}040) = \$2{,}208{,}000$

d. Which strategy will include the highest total revenue? How much higher in \$ and % of this strategy comparing with the other two policies?

Strategy	**One-tier**	**Two-tier**	**Three-tier**
TR	1,666,666.67	2,024,000.00	2,208,000.00
Gap	541,333.33	184,000.00	-
%	32.48%	9.09%	0.00%

Q6.

The Park Hyatt Philadelphia has 118 King/Queen rooms. Full fare is \$225 targeting business travelers. Also, Hyatt offers a discount fare of \$159 for a mid-week stay targeting leisure travelers. Demand for low fare rooms is abundant. Most of the high fare demand occurs within a few days of the actual stay and follows an exponential distribution with mean 27.3.

a. What are the unit overstocking cost and the unit understocking cost?

b. What are the probability of overstocking and the probability of understocking?

c. How many rooms should be protected for full fares to minimize expected cost (maximize expected total revenue)? Hint: Use inverse-transformation of exponential cumulative distribution.

(Requirement: Show step-by-step manual calculation for this problem)

$p_F = \$225; p_D = \$159; D_F \sim Expo(\frac{1}{27.3}); D_D = \infty$

a. What are the unit overstocking cost and the unit understocking cost?

- $c_o = p_D = \$159$
- $c_u = p_F - p_D = 225 - 159 = \$66$

b. What are the probability of overstocking and the probability of understocking?

$$F(x^*) = \Pr(Y \le x^*) = \frac{c_u}{c_u + c_o} = \frac{66}{66 + 159} = \frac{22}{75} \approx 29\%$$

$$1 - F(x^*) = \Pr(Y \ge x^*) = \frac{c_o}{c_u + c_o} = \frac{159}{66 + 159} = \frac{53}{75} \approx 71\%$$

c. How many rooms should be protected for full fares to minimize expected cost (maximize expected total revenue)? Hint: Use inverse-transformation of exponential cumulative distribution.

$$Exp(\lambda) = Exp\left(\frac{1}{\mu}\right) \rightarrow \lambda = \frac{1}{27.3}$$

$F(x^*) = \Pr(Y \le x^*) = 1 - e^{-\lambda x^*}$, with $x^* \ge 0$

$$\rightarrow x^* = -\frac{1}{\lambda}\ln[1 - \Pr(Y \le x^*)] = -27.3 \times \ln\left(1 - \frac{22}{75}\right) = 9.47 \approx 9\ (rooms)$$

Q7.

Icie is a chain of retail stores that sells 32 flavors of slushy – a partially frozen drink made with crushed ice and fruit-flavored syrup. The weekly demand for each flavor of slushy is independent and is normally distributed with N(100,121). The replenishment lead time from the factory is three weeks and Icie aims for a customer service level of 95%.

a. How much safety stock will Icie have to hold if the slushies are mixed at the factory and held in inventory at the retail store as individual flavors?

b. How does the safety stock requirement change if Icie holds the crushed ice and adds the fruit-flavored syrup on demand?

c. Based on the results of part a and b, which strategy should Icie use to optimize the amount of safety stock? Why?

(Requirement: Show step-by-step manual calculation for this problem)

$k = 32; CSL = 0.95; D = 100; \sigma_D = \sqrt{121} = 11; L = 3$

a. How much safety stock will Icie have to hold if the slushies are mixed at the factory and held in inventory at the retail store as individual flavors?

- $ss_{decentralized} = k \times F_S^{-1}(CSL) \times \sqrt{L} \times \sigma_D = 32 \times 1.645 \times \sqrt{3} \times 11 = 1{,}003$

b. How does the safety stock requirement change if Icie holds the crushed ice and adds the fruit-flavored syrup on demand?

- $\sigma_D^C = \sqrt{k} \times \sigma_D = \sqrt{32} \times 11 = 62.23$
- $ss_{aggregated} = F_S^{-1}(CSL) \times \sqrt{L} \times \sigma_D^C = 1.645 \times \sqrt{3} \times 62.23 = 177$

c. Based on the results of part a and b, which strategy should Icie use to optimize the amount of safety stock? Why?

Icie should hold the crushed ice and add the fruit-flavored syrup on demand since this strategy results in lower safety stock level ($ss_{aggregated} = 177 < 1{,}003 = ss_{decentralized}$).

Q8.

a. What are the benefits and drawbacks of postponement?

b. A new technology allows books to be printed in 10 minutes. Fahasa has decided to purchase these machines for each store. It must decide which books to carry in stock and which books to print on demand using this technology. Do you recommend it for best sellers or for other books? Why?

a. **What are the benefits and drawbacks of postponement?**

Benefits	Drawbacks
• Reduce the amount of incorrect inventory, expedited delivery expenses, and obsolete and markdown items. • Component manufacture in low-cost countries becomes more efficient. • Customers have more options without incurring more fees. • With less assets and capital, global markets are reached faster. • For new items, deeper customer insights are gathered. • It is possible to concentrate on supply innovation and product design. • There is time to focus on high-value intellectual property rather than routine execution approaches.	• Demand that is unpredictable and negatively connected. • Too many alternatives for localization. • Longer lead times, higher inventory levels, and inventory that is skewed.

b. **A new technology allows books to be printed in 10 minutes. Fahasa has decided to purchase these machines for each store. It must decide which books to carry in stock and which books to print on demand using this technology. Do you recommend it for best sellers or for other books? Why?**

Fahasa should carry in stocks for best sellers because they have steady demand, less demand uncertainty and are more likely to be sold. Books belonging to unique genres or aimed at a specified customer target can be printed on demand using the new technology since the product variation is high.

Q9.

Apple manufactures 20 laptops with four distinct components: processor, memory, hard drive and motherboard. Under the disaggregate option, Apple designs specific components for each laptop, resulting in 20x4=80 distinct components. Under the common-component option, Apple designs laptops such that two distinct processors, two distinct memory units, two distinct hard drives and two distinct motherboards can be combined to create 20 laptops. Monthly demand for each of the 20 laptops is independent and normally distributed, with a mean of 10,000 and a standard deviation of 2,000. The replenishment lead time for each component is one month. Apple is targeting a CSL of 95 percent for component inventory.

a. Evaluate the safety inventory requirements with and without the use of component commonality.

b. Calculate the percentage of safety inventory that was reduced by using component commonality.

(Requirement: Show step-by-step manual calculation for this problem)

Let NORMSINV(0.95) = 1.645.

a. Evaluate the safety inventory requirements with and without the use of component commonality.

We first evaluate the disaggregate option, in which components are specific to a laptop. For each component, we have:

- $Standard\ deviation\ of\ monthly\ demand\ =\ 2{,}000$

Given a lead time of one month and a total of 80 components across 20 laptops, we obtain:

- $Total\ safety\ inventory\ required = 80 \times NORMSINV(0.95) \times \sqrt{1} \times 2{,}000 = \mathbf{263{,}200}\ units$

In the case of component commonality, each component ends up in 10 finished products (20 laptops divided by 2 types of processors/memory units/hard drives/motherboards). Therefore, the demand at the component level is the sum of demand across 10 products.

- $Safety\ inventory\ per\ common\ component = NORMSINV(0.95) \times \sqrt{1} \times \sqrt{10} \times 2{,}000 = 10{,}404\ (units)$

With component commonality, there are a total of 8 distinct components (2 distinct processors + 2 distinct memory units + 2 distinct hard drives + 2 distinct motherboards).

- $Total\ safety\ inventory\ required\ =\ 8 \times 10{,}404 = \mathbf{83{,}232}$

Thus, having each component common to 8 products results in a reduction in safety inventory for Apple from 263,200 to 83,232 units.

b. Calculate the percentage of safety inventory that was reduced by using component commonality.

$$Reduction\ percentage = \left(\frac{263{,}200 - 83{,}232}{263{,}200}\right) \times 100 = 68.38\%$$

Q10.

a. Give an example of modular and nonmodular products and processes.
b. How do standardization strategies help managers deal with demand variability and the difficulty of making accurate forecasts?
c. What are the advantages and disadvantages of integrating suppliers into the product development process?

a. Give an example of modular and nonmodular products and processes.

- **Modular products:** The classic example of a modular product is the personal computer, which can be customized by combining different video cards, hard drives, memory chips, and so forth.
- **Modular process:** A manufacturing process consists of discrete operations, so that inventory can be stored in partially manufactured form between operations.
- **Nonmodular products:** The glasses, table, chair which cannot be customized.
- **Nonmodular process:** A manufacturing process consists of integration operations, so that inventory cannot be stored in partially manufactured form between operations.

b. How do standardization strategies help managers deal with demand variability and the difficulty of making accurate forecasts?

Standardization strategies assist managers in dealing with demand fluctuation and accurate forecasts by reducing the uncertainty of forecasts by employing aggregate forecasting across all goods, resulting in a more accurate forecast. Standardization aids managers in dealing with demand variability by allowing items to be differentiated based on demand at the point of sale. As a result, the items that buyers want are those that are assembled using component parts that may also be utilized for other products

c. What are the advantages and disadvantages of integrating suppliers into the product development process?

Advantages:

- Increasing collaboration and visibility.
- The organization may not have the expertise to manufacture those new things.
- Firms with greater agility may be better able to adapt to unpredictability by identifying and eliminating waste in the supply chain.
- Increasing profit margins.

Disadvantages:

- If the terms of supply chain integration do not meet their business goals, it will have an impact on procurement and supply costs, as those who are willing to follow the new rules may pay a higher price.

If there is a lapse in inspections or compliance, the entire system will be brought down.