REVIEW FOR MIDTERM EXAM II

The Line Balancing Problem

- The problem is to arrange the individual tasks at the workstations so that the total time required at each workstation is approximately the same.
- Note that it is nearly impossible to reach perfect balance

Line Balancing

$$\text{Required cycle time} = \frac{\text{Production time per day}}{\text{Demand per day}}$$

The **actual cycle time which** is the maximum workload assigned to a workstation should be either equal to or less than the required cycle time. Otherwise, the desired output per day can not be achieved.

Note that Cycle Time is the time between parts coming off the line.

Question 1: A Line Balancing «Most Following Tasks»

Work Element	Description	Time (min)	Immediate Predecessor(s)
A	Tan leather	30	-
B	Dye leather	15	A
C	Shape case	5	B
D	Mold hinges and fixtures	15	-
E	Install hinges and fixtures	10	C,D
F	Assemble case	10	E

If the demand is 12 cases per 8-hour day, compute a) the required cycle time b) min. # of WSs. required to satisfy the demand c) min and max output per day d) Balance the line using «most following heuristic» e) efficiency and balance delay, f) tot. cycle time per day

Question 2:
Chapter 9, Problem 16, Line Balancing

•• **9.15** The following table details the tasks required for Dallas-based T. Liscio Industries to manufacture a fully portable industrial vacuum cleaner. The times in the table are in minutes. Demand forecasts indicate a need to operate with a cycle time of 10 minutes.

Activity	Activity Description	Immediate Predecessors	Time
A	Attach wheels to tub	—	5
B	Attach motor to lid	—	1.5
C	Attach battery pack	B	3
D	Attach safety cutoff	C	4
E	Attach filters	B	3
F	Attach lid to tub	A, E	2
G	Assemble attachments	—	3
H	Function test	D, F, G	3.5
I	Final inspection	H	2
J	Packing	I	2

Question 2:
Chapter 9, Problem 16, Line Balancing

a) Draw the precedence diagram

b) Calculate the minimum and maximum output possible per 8-hr day

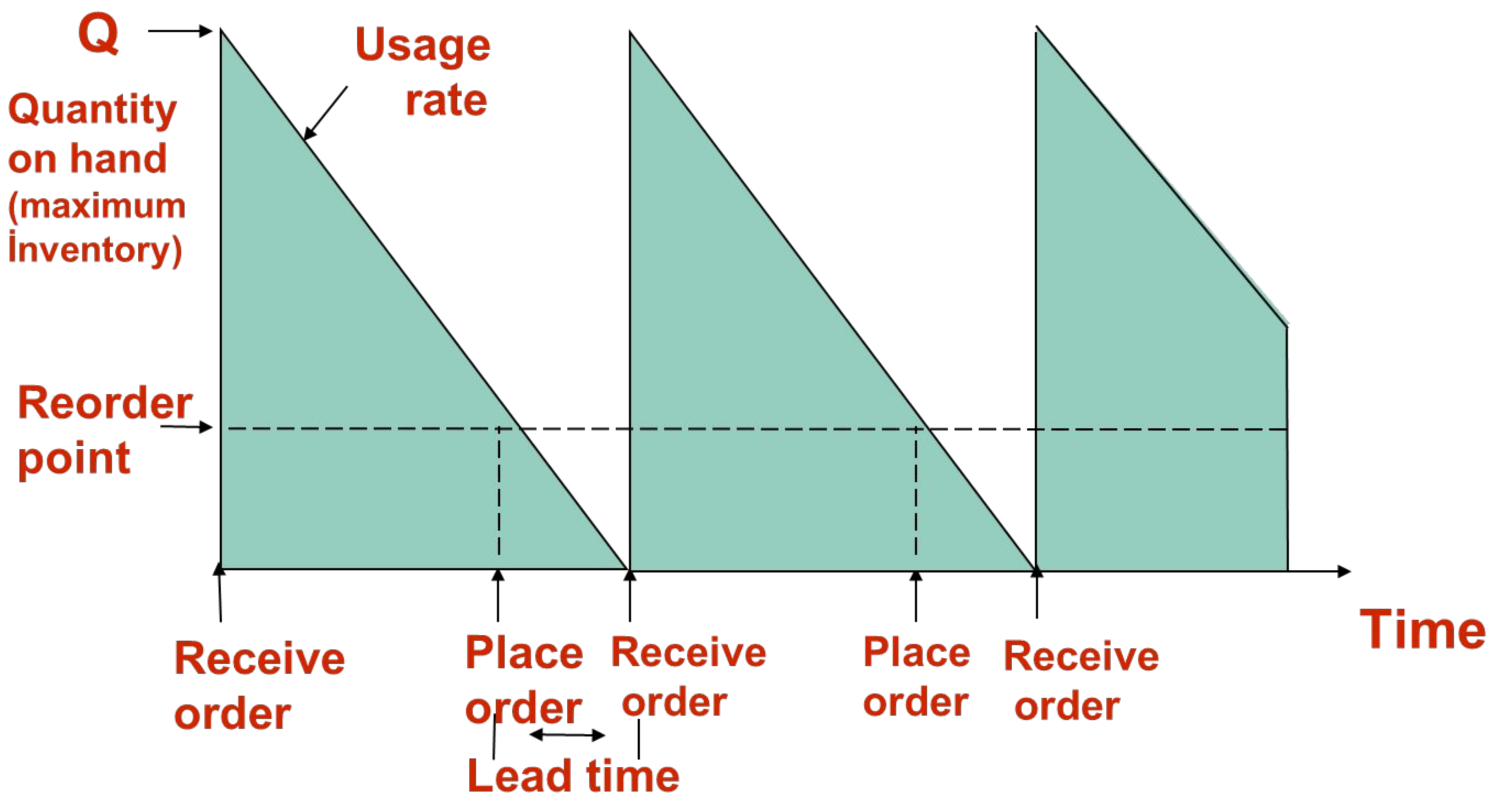
c) Calculate min. # of WSs. required to satisfy the demand

d) Balance the line using «most following heuristic» to satisfy the demand

e) Calculate efficiency and balance delay

f) Calculate total idle time per day

Inventory Management
EOQ Model



Inventory Management

Objective is to minimize total costs

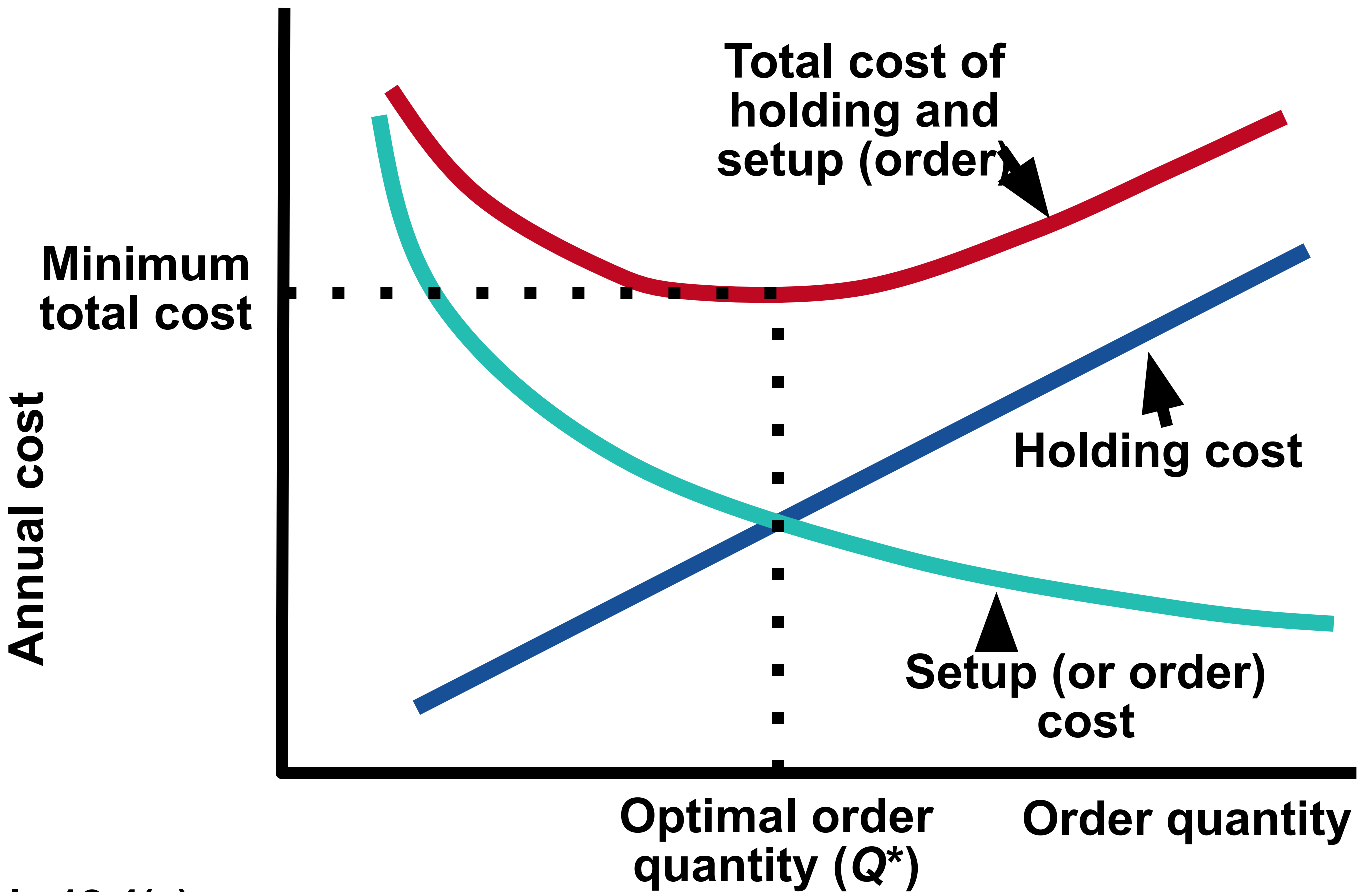
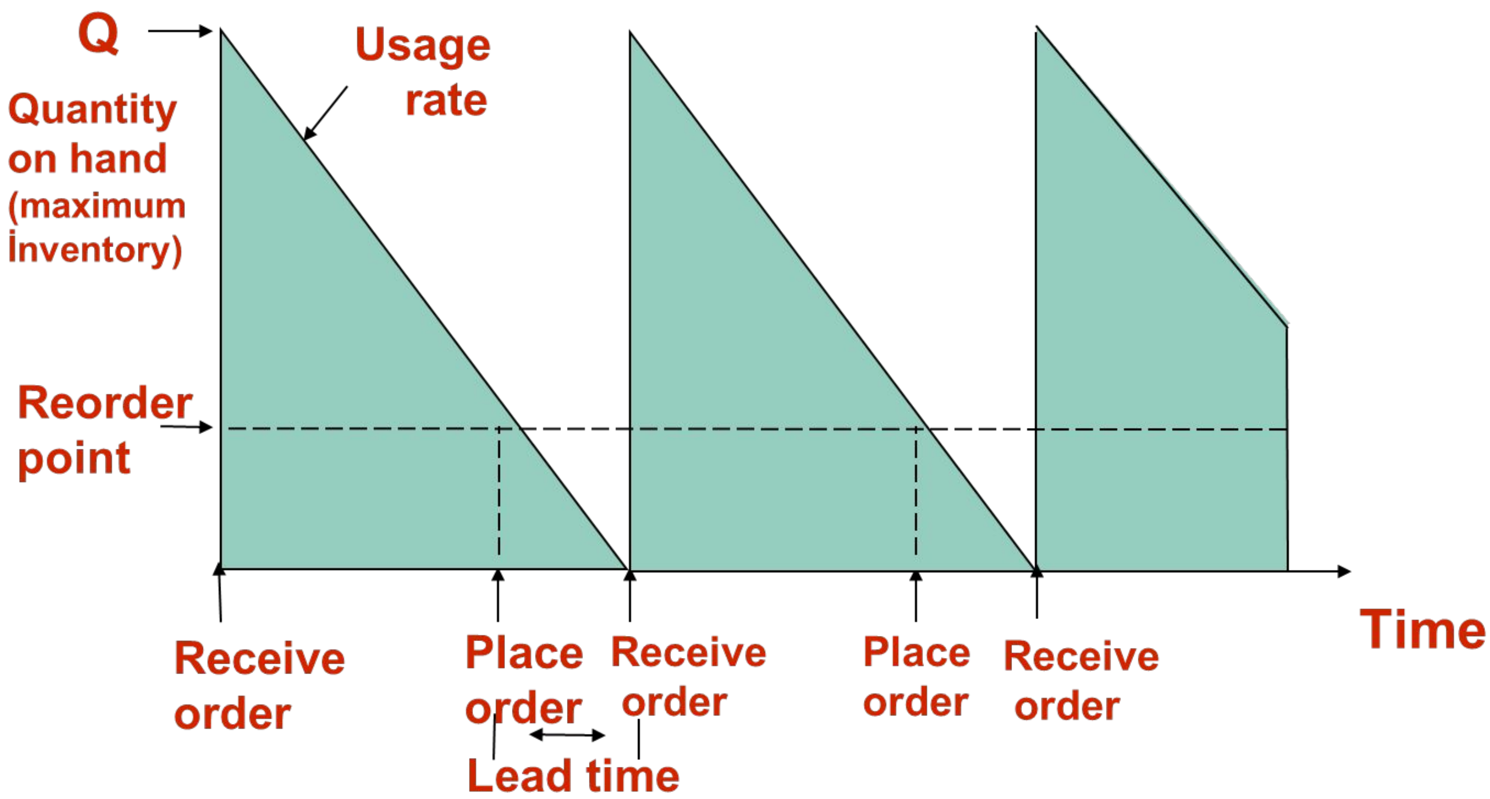


Table 12.4(c)

Inventory Management
EOQ Model



EOQ Model Equations

$$\text{Optimal Order Quantity} = Q^* = \sqrt{\frac{2 \cdot D \cdot S}{H}}$$

$$\text{Expected Number Orders} = N = \frac{D}{Q^*}$$

$$\text{Expected Time Between Orders} = T = \frac{\text{Working Days / Year}}{N}$$

$$d = \frac{D}{\text{Working Days / Year}}$$

$$ROP = d \cdot L$$

D = Demand per year

S = Setup (order) cost per order

H = Holding (carrying) cost

d = Demand per day

L = Lead time in days

Question 3, EOQ

The ABC store needs 1000 coffee makers per year. Ordering cost is $100 per order. Carrying cost per unit per year is $32.20. Lead time is 5 days. The store is open 365 days/yr. Calculate:

a) Economic Order Quantity(EOQ),
b) Total annual cost
c) Reorder Point
d) Expected time between orders

Production Order Quantity Model

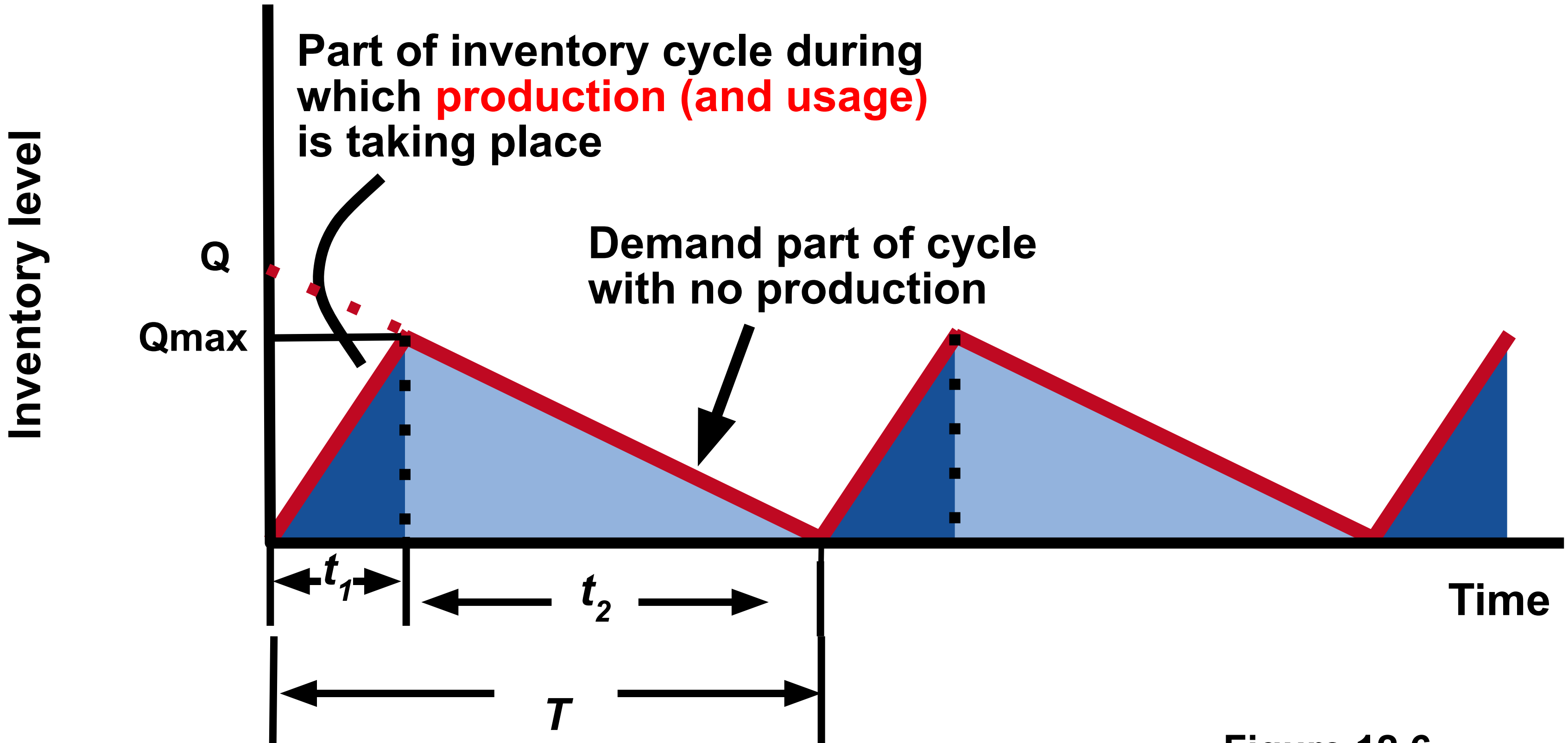


Figure 12.6

EOQ and POQ Models

In the EOQ model, maximum inventory is equal to the Order Size (Q).

Average Inventory = Q/2

In the POQ model, maximum inventory is less than the Order Size.

Why? Because we produce the item and use it while it is being produced.

Average Inventory = Q_{max} / 2

where Q_{max} = (p-d)Q/p

POQ Model

$$Q_p^* = \sqrt{\frac{2DS}{H(1 - d/p)}}$$

D – annual demand

S – Setup cost

H – Holding cost

d – daily demand rate

p – daily production rate

TC= (Q_{max}/2) H + (D/Q*) S

Question 4, POQ

A plant manager of XYZ chemical plant must determine the lot size for a particular chemical. The production rate is 190 barrels/day, annual demand is 10,500 barrels, setup cost is $200 per order, annual holding cost is $0.21/barrel, and the plant operates 350 days/year.

a. What is the optimal production quantity?
b. What is the optimal number of production runs per year?
c. What is the time between production runs?
d. What is the total annual cost?
e. What is the percent of time spent for production.

Question 5:Chapter 12, Problem 20, POQ

•• **12.18** Arthur Meiners is the production manager of Wheel-Rite, a small producer of metal parts. Wheel-Rite supplies Cal-Tex, a larger assembly company, with 10,000 wheel bearings each year. This order has been stable for some time. Setup cost for Wheel-Rite is $40, and holding cost is $.60 per wheel bearing per year. Wheel-Rite can produce 500 wheel bearings per day. Cal-Tex is a just-in-time manufacturer and requires that 50 bearings be shipped to it each business day.

a) What is the optimum production quantity?
b) What is the maximum number of wheel bearings that will be in inventory at Wheel-Rite?
c) How many production runs of wheel bearings will Wheel-Rite have in a year?
d) What is the total setup + holding cost for Wheel-Rite?

Quantity Discount Model

- **Same as the EOQ model, except:**
  - **Unit price depends upon the quantity ordered**

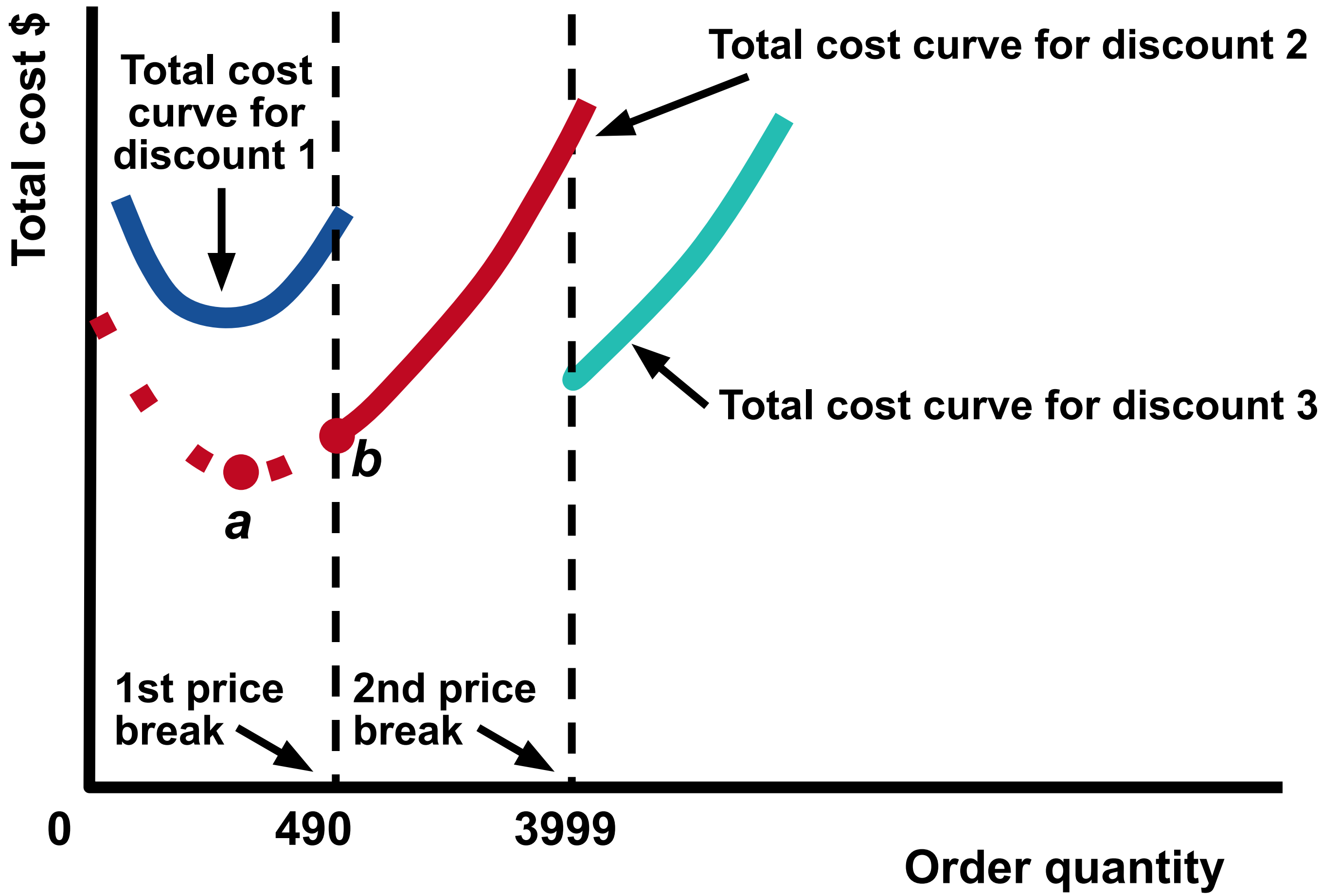
- **The total cost equation becomes:**

$$TC_{QD} = \left(\frac{D}{Q}S\right) + \left(\frac{Q}{2}H\right) + PD$$

Question 6: Quantity Discount Model

ABC Sport store is considering going to a different hat supplier. The present supplier charges $10/hat and requires minimum quantities of 490 hats. New supplier is offering hats at $9 in lots of at least 4000 or more. The annual demand is 12,000 hats, the ordering cost is $20 per order, and the annual inventory carrying cost per unit is 20% of the hat cost. What should be optimum order quantity?

Holding Cost= 0.20 x Purchasing price

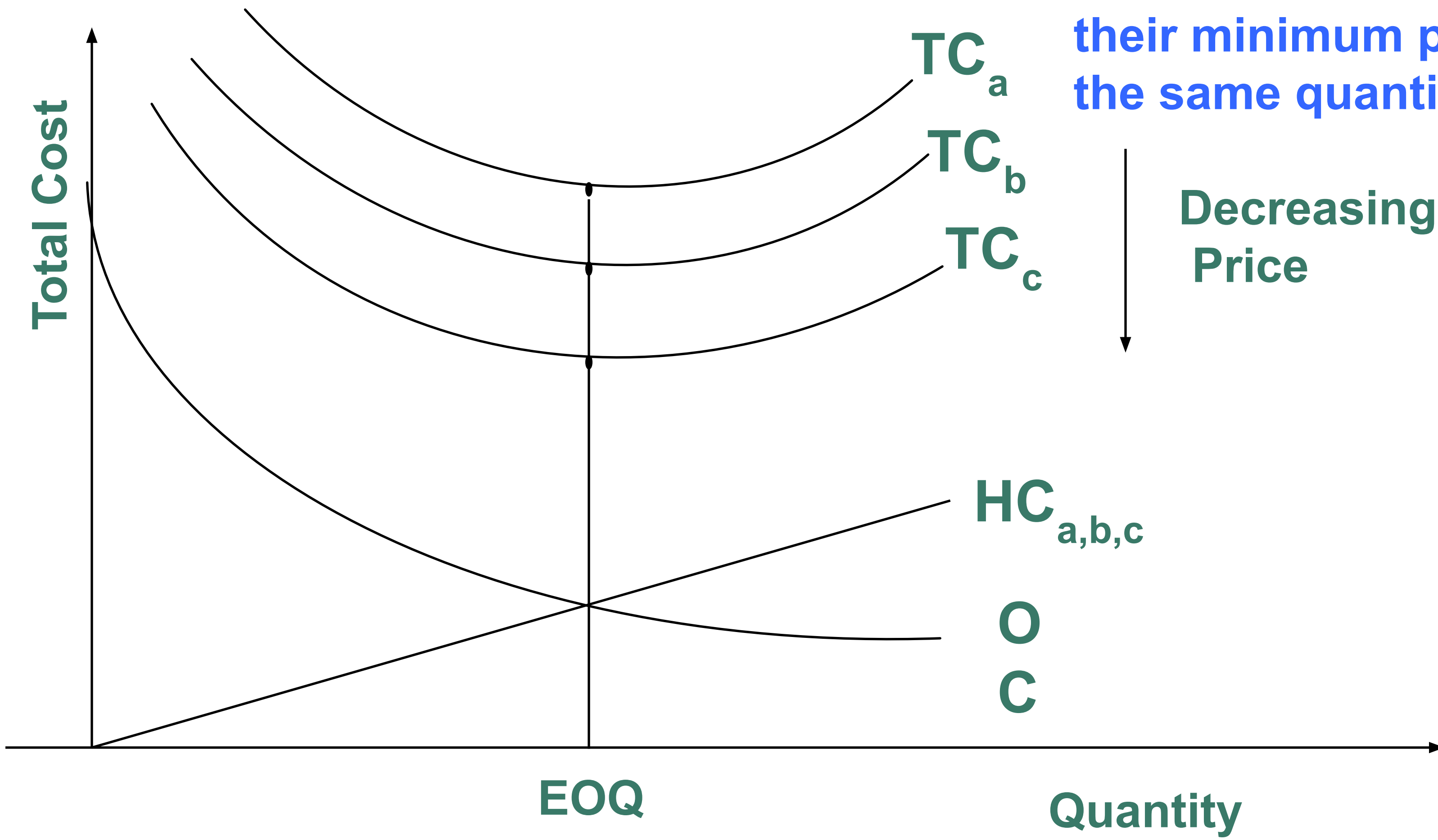


Question 7: Quantity Discount Model

A company has a chance to reduce their inventory ordering costs by placing larger quantity orders using the price-break order quantity schedule below. **What should their optimal order quantity** be if this company purchases this single inventory item with an e-mail ordering cost of $4 per order, annual inventory carrying cost of $0.30 per unit, and an annual demand of 300 000 units?

Order Quantity(units)	Price/unit($)
0 to 2,499	$1.20
2,500 to 3,999	1.00
4,000 or more	.98

Total Cost with Constant Holding Costs



In this case there is a single minimum point; all curves will have their minimum point at the same quantity

Question 8: Reorder Point for Variable Demand

The manager of a carpet store wants to determine the reorder point and the amount of safety stock to keep with a 97% service level. Daily demand is normally distributed with a mean of 30 yards and standard deviation of 5 yards per day. Lead time is 10 days.

Demand per day is variable and lead time (in days) is constant

ROP =(*Average* daily demand)
* Lead time in days) + $Z\sigma_{dLT}$

where $\sigma_{dLT} = \sigma_d \sqrt{\text{Lead time}}$

σ_d = standard deviation of demand per day

Tables of the Normal Distribution

Probability Content from -oo to Z

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Question 9: Aggregate Production Planning

ABC Company has the following aggregate demand requirements for the upcoming four quarters:

Quarter	Demand			
			Previous quarter's output	1425 units
1	1500		Beginning inventory	100 units
2	1800		Subcontacting Cost	$50 per unit
3	1600		Inventory holding cost	$10 per quarter/unit
4	1200		Hiring workers	$40 per unit
			Laying off workers	$80 per unit
			Production cost	$30 per unit

Question 9: Aggregate Production Planning

Which of the following production plans is better:

Plan A–chase demand by hiring and layoffs

Plan B–level strategy and subcontracting

Calculate the total cost of each production plan.

a) Chase Demand

	Demand	Regular Time Production	Units Increase	Units Decrease
Quarter 1				
Quarter 2				
Quarter 3				
Quarter 4				
Total Units				
Total Cost				

b) Level Production

	Demand	Regular Time Production	Backordering	Inventory	Units Increase	Units Decrease
Quarter 1						
Quarter 2						
Quarter 3						
Quarter 4						
Total Units						
Total Cost						