Unacademy

Mechanical Engineering

Toppers Handwritten Notes

Industrial Engineering

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Industrial Engineering

Classroom Notes

[Handwritten]

For GATE | ESE | PSU's

Mechanical Engineering

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Chapter-1

Inventory Control

7/07/21

Industrial Engineering

- GATE - 5-6 Marks
- ESE (Pre.) - 4-7 Questions (8-14 Marks)
- Mains - 50 Marks.

Index.

- Inventory Control (Management)
- Break even analysis (BEA)
- Sequencing and scheduling
- Forecasting
- Queuing theory
- MRP
- Project management (PERT & CPM)
- Linear programming
- Assignment problem
- Transportation
- Assembly line balancing

07/07/21

ch-1 Inventory Control.

Inventory is defined as any idle resource of an enterprise. It is a physical stock of goods kept for future use.

Inventory may be in the form of raw materials, Semifinished goods, parts. It may also include furniture, machinery etc.

Note:

- Inventory is stock in hand to meet to unforeseen demand.
- Too much inventory is a sign of inefficiency.

Type's of inventories:

1. Raw materials
2. Bought out parts
3. Work in progress inventory (semi-finished inventory)
4. Finished goods inventories
5. Indirect inventories (Normally they do not form part of ~~operating stores~~ final product but are consumed in production (oil, grease etc.)).
6. Miscellaneous inventories (Ex: office stationary)

Reason for maintaining inventory:

- To ensure smooth and efficient running of business.
- To provide adequate service to customers.
- To avoid shortage.
- To meet unexpected demand.
- To take advantage of price discount (usually manufactures offer discount for bulk buying and to gain this price advantage, the material are brought in bulk eventhough it is not required immediately. Thus inventory is maintained to gain economy in purchasing).
- To prevent loss of sales.

Costs associated with inventory:

(1) Unit cost / Item cost (c)

(2) Order cost / ordering cost (C_o):

Assumption: ordering cost is independent of size of order.

→ people
- Transportation

- Inspection / Quality check
- Rejection cost
- Delay cost
- Follow up

(3) Holding or carrying cost (C_c):

- Space (rental)
- power (A/c etc.) / special requirement.
- obsolete item
- pilferage
- cost of capital
- Insurance / taxes
- Security / staff
- Damage cost

C_c = holding cost/unit/time (year, month etc)

(4) shortage / backorder cost (C_s):-

- loss of profit
- lost sale
- loss of opportunity
- under utilisation
- Rescheduling
- Additional capacity / freight charges.
- loss of customer good will.

Inventory models:

- Deterministic Model
- probabilistic Model

(1) Deterministic model:

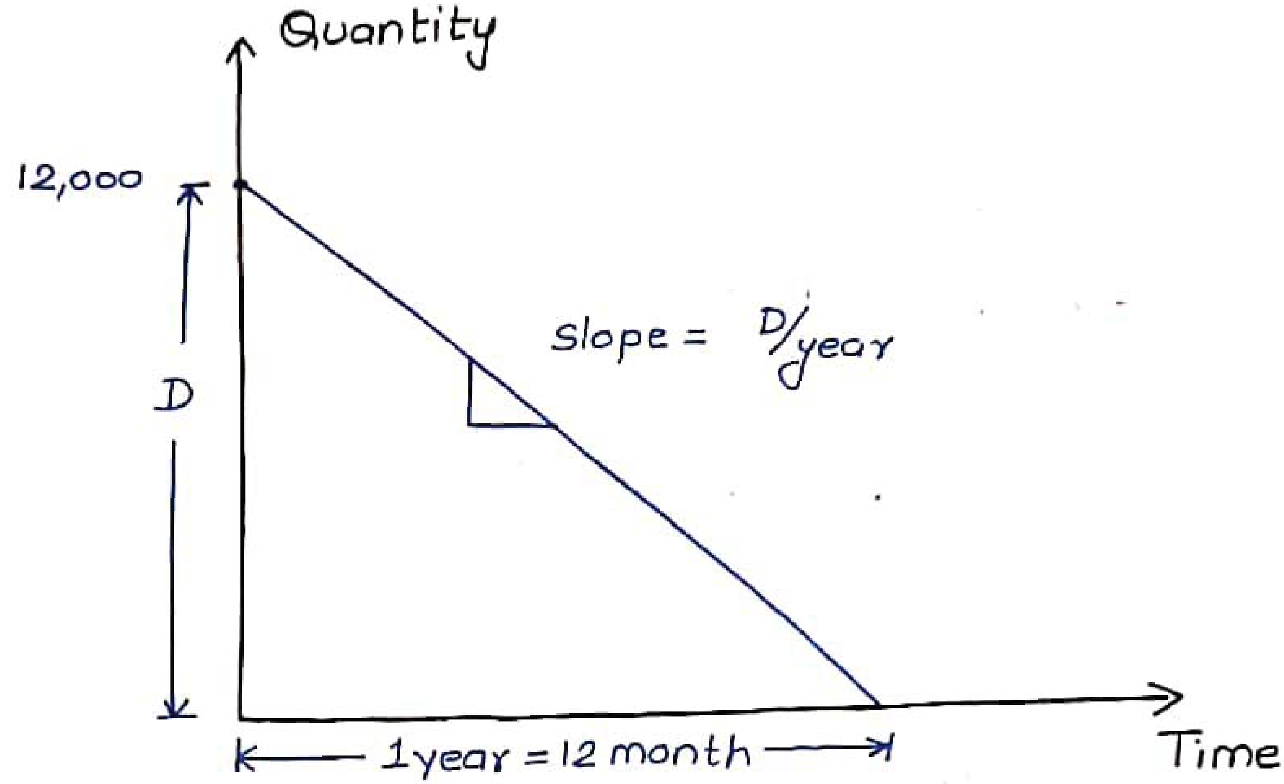
- demand is known and certain.

(a) Basic inventory model (Wilson-Haris model)/ Purchasing model:

Assumption:

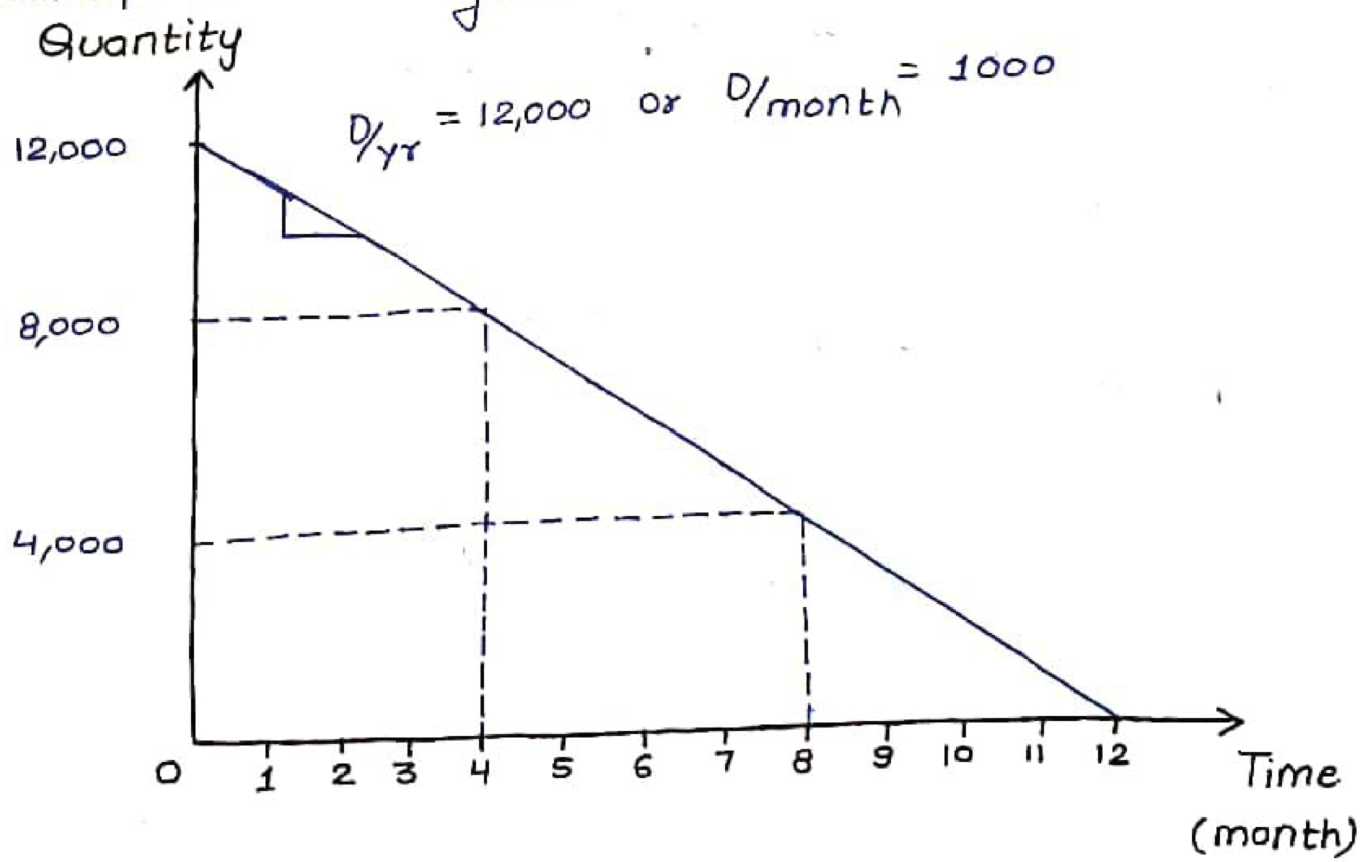
1) demand is uniform.
2) Unit cost of item is constant/Fixed. (No discount is allowed).
3) Lead time is zero. (Lead time is the time between placing the order and receiving the order.)
4) Instantaneous replenishment
5) No buffer or safety stock.
6) No shortage.
7) Cycle time is Fixed or Same.

Let D = Annual demand or demand per year.



Let us assume, for an item annual demand is 12,000 per year.

Consumption = 12000/year or 1000 unit per month.



12,000 → 4,000
12,000 → 4,000
12,000 → 4,000

No. of orders (n) = 3

<u>case:1</u>

Let n = 1
- ordering cost ↓
- holding cost ↑

<u>case:2</u>

n=2
- ordering cost ↑
- holding cost ↓

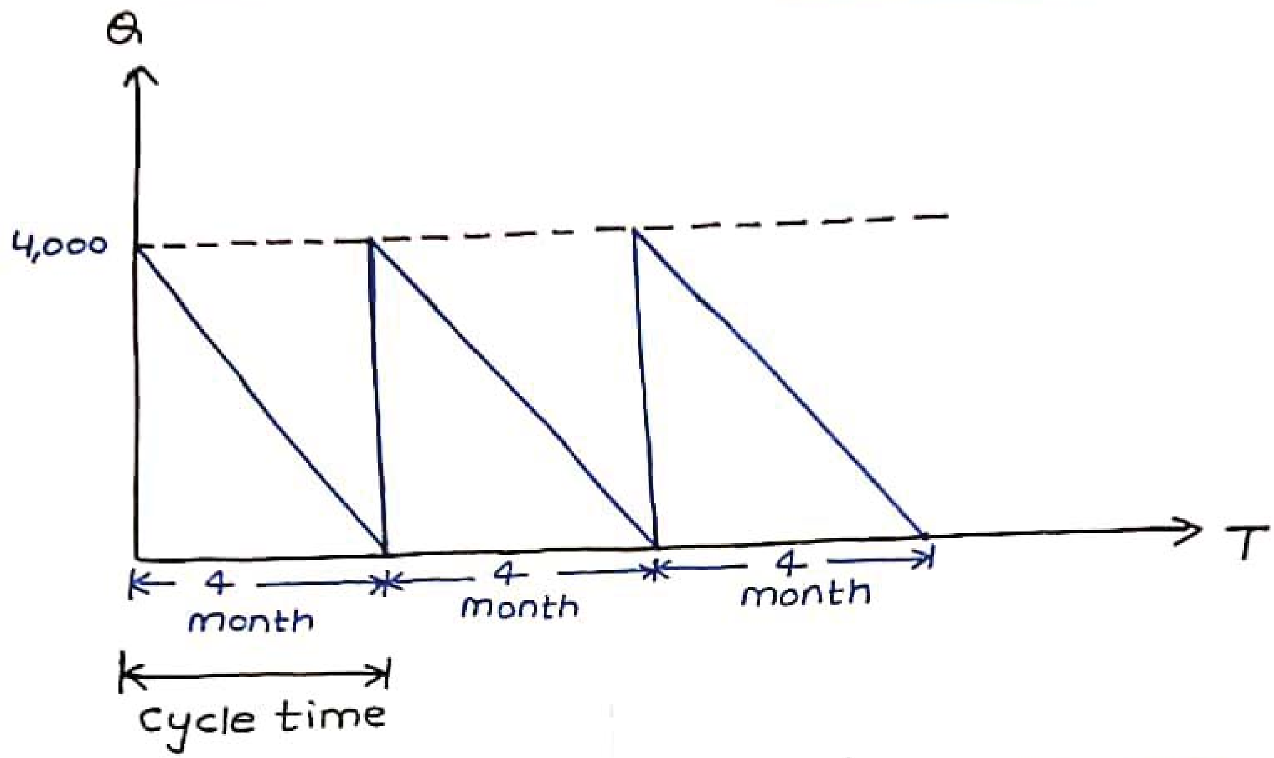
} compare to case 1

When no. of orders are less, ordering cost is less but holding cost is more. So, we place such an order for which total cost is less.

Total Variable cost (TVC) = ordering cost + holding cost

Total inventory cost (TIC) or total cost =

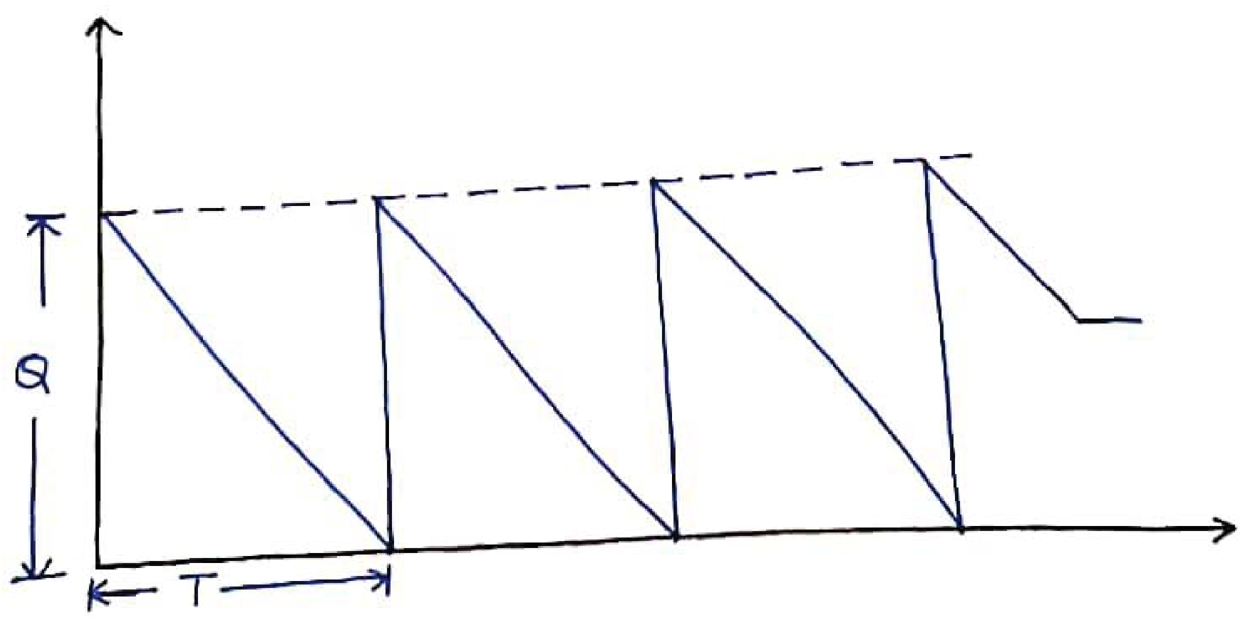
= Item cost + total Variable cost



Let D = annual demand or demand per year

Q = Quantity

So, No. of orders/year = D/Q

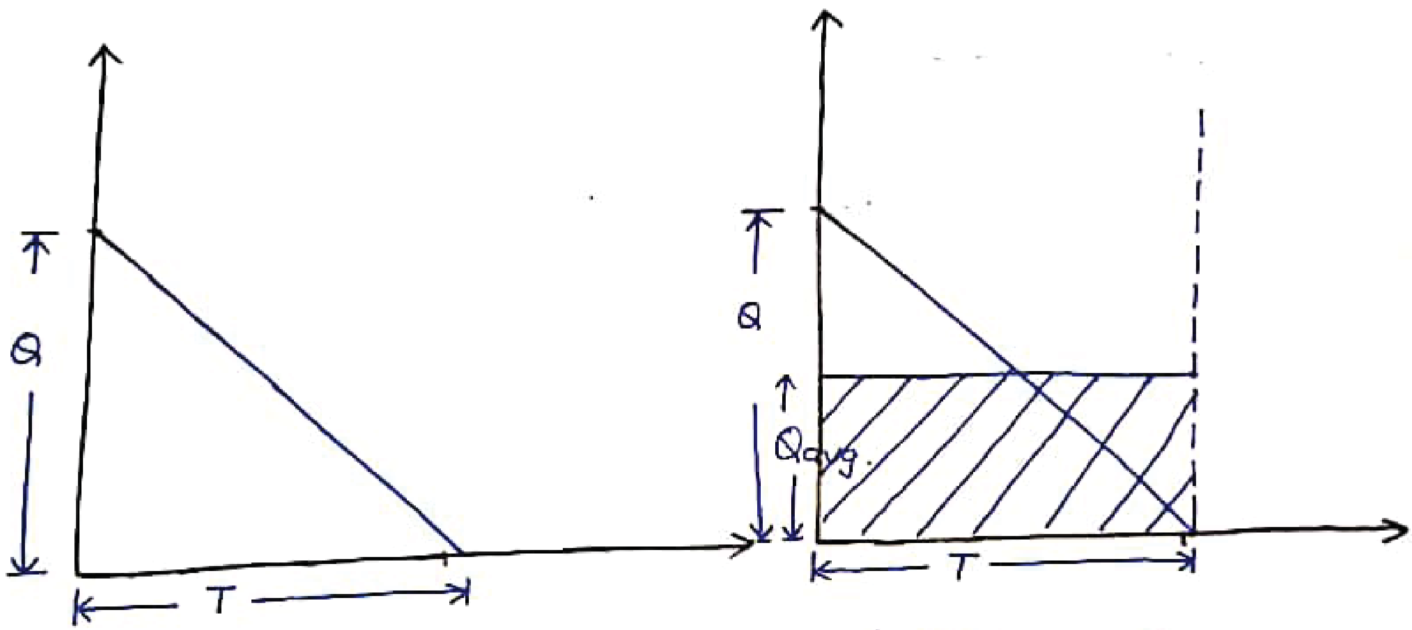


C_o = ordering cost or cost per order.

Total ordering cost = No. of orders/year $\times$ C_o

Total ordering cost = $\frac{D}{Q} \times C_o$ —— (1)

C_c = holding or carrying cost/unit/time.



$$Q_{avg} = \frac{\text{Cycle area}}{\text{Cycle time}} = \frac{\frac{1}{2}QT}{T} = \frac{Q}{2}$$

Total carrying cost = $C_c \times Q_{avg}$.

$$= C_c \times \frac{Q}{2}$$

Total variable cost = total ordering cost + total carrying cost

$$= \frac{D}{Q} C_o + \frac{Q}{2} C_c$$

Total inventory cost or total cost =

= total item cost + total variable cost

$$T.C. = \underbrace{D \times C}_{\text{constant}} + \frac{D}{Q} C_o + \frac{Q}{2} C_c$$

For minimum total cost $\frac{d(T.C.)}{dQ} = 0$

$$= \frac{d}{dQ}\left[D \times C + \frac{D}{Q} C_o + \frac{Q}{2} C_c \right] = 0$$

$$\Rightarrow \quad 0 - \frac{D C_o}{Q^2} + \frac{C_c}{2} = 0$$

$$\frac{C_c}{2} = \frac{D C_o}{Q^2}$$

$$Q^2 = \frac{2 D C_o}{C_c}$$

$$Q = \sqrt{\frac{2 D C_o}{C_c}}$$

$$EOQ = Q^* = \sqrt{\frac{2 D C_o}{C_c}}$$

(Economic order quantity)

↳ it is such a quantity where the total cost is optimum or minimum.

Ordering cost = $\frac{D}{Q} C_o$

holding cost = $\frac{Q}{2} C_c$

$$EOQ = Q^* = \sqrt{\frac{2DC_o}{C_c}}$$

Ordering cost at optimum conditions (min. cost):

$$\Rightarrow \frac{D}{Q^*} C_o = \frac{DC_o}{\sqrt{\frac{2DC_o}{C_c}}} = \sqrt{\frac{DC_oC_c}{2}} = \frac{1}{\sqrt{2}}\left[\sqrt{DC_oC_c}\right]$$

holding cost at optimum condition:

$$\Rightarrow \frac{Q^*}{2} C_c = \sqrt{\frac{2DC_o}{C_c}} \times \frac{C_c}{2}$$

$$= \frac{1}{\sqrt{2}}\left(\sqrt{DC_oC_c}\right)$$

Note: At optimum condition, ordering cost and holding cost are same.

Total min. variable cost (optimum condition)

$$= \frac{1}{\sqrt{2}}\left[\sqrt{DC_oC_c}\right] + \frac{1}{\sqrt{2}}\left[\sqrt{DC_oC_c}\right]$$

$$= \sqrt{2DC_oC_c}$$