Value.

$$F_t = F_{t-1} + \alpha(D_{t-1} - F_{t-1})$$

F_t = Smoothed Avg. forcast for period

F_{t-1} = previous period forecast.

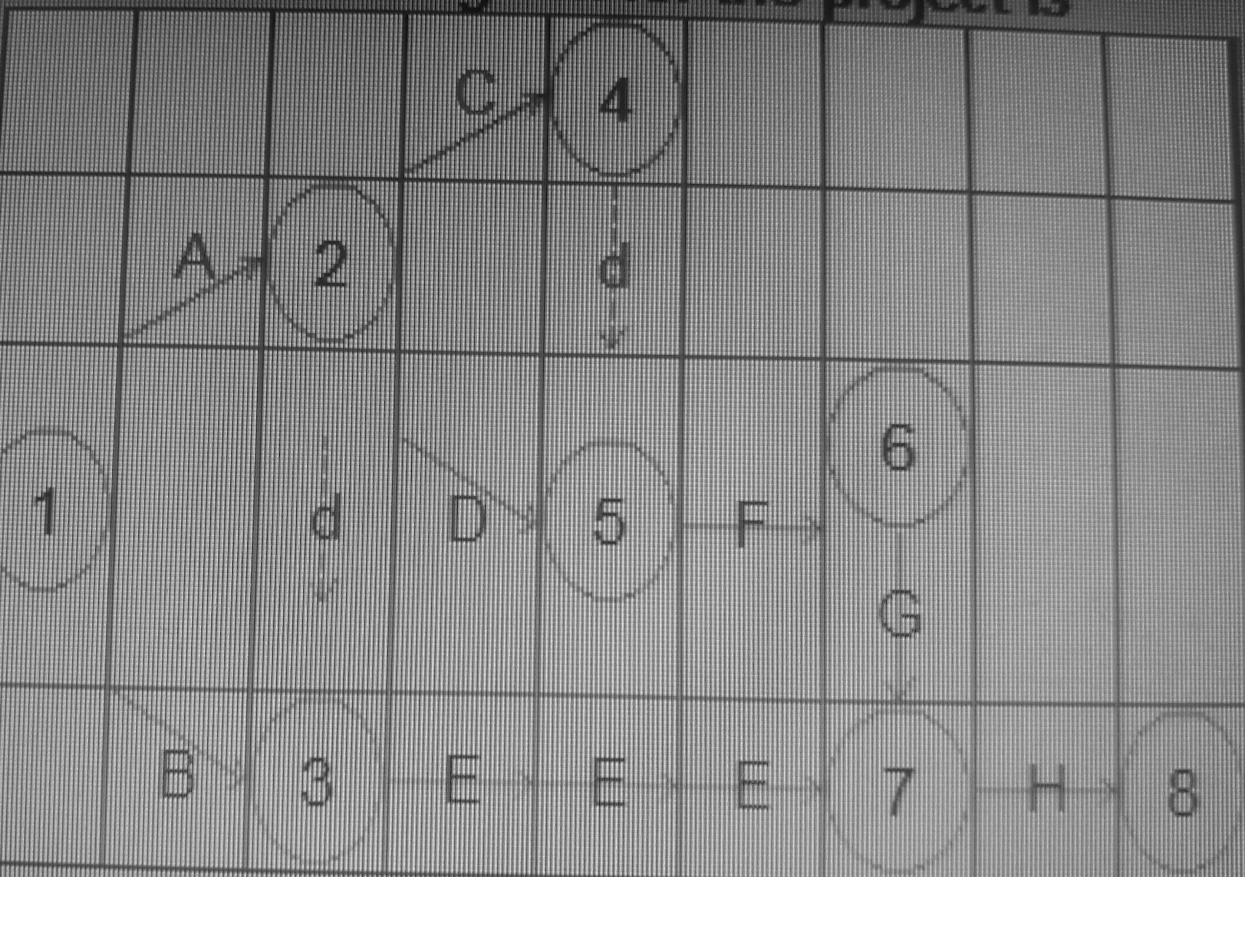
α = Smoothing constant

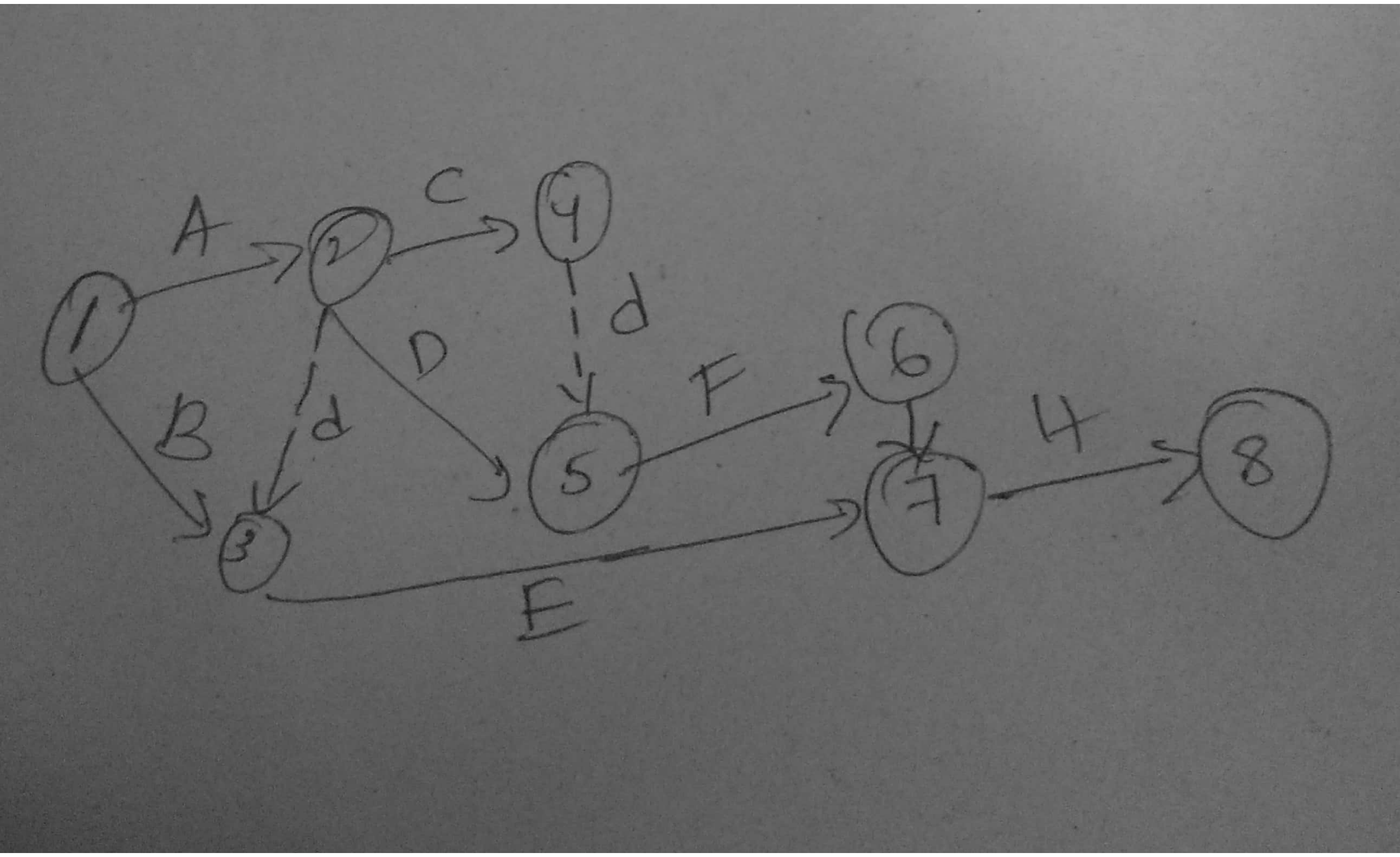
D_{t-1} = Previous period demand.

If α is equal 1, then the latest fore is would be equal to previous period actual demand.

The preferred range for α is 0.1 to 0.

The network diagram for the project is




A
B
C
D
d
d
E
F
4
1
2
3
4
5
6
7
8

SOLUTION

(i) Mean absolute deviation (MAD) :

$$= \frac{\Sigma(A_t - F_t)}{n}$$

Period	Actual Demand	Forecasted Demand	Error
1	142	155	-13
2	181	157	24
3	144	159	-15
4	174	161	13
5	192	163	29
6	176	165	11

$$= \frac{|13 + 24 + 15 + 13 + 29 + 11|}{6}$$

$$= \frac{105}{6}$$

MAD = 17.5

(ii) Mean Squared Error (MSE)

$$= \frac{\sum(A_t - F_t)^2}{n}$$

$$= \frac{(-13)^2 + 24^2 + (-15)^2 + 13^2 + 29^2 + 11^2}{6}$$

$$= \frac{169 + 567 + 225 + 169 + 841 + 121}{6}$$

$$= \frac{2092}{6}$$

MSE = 348.66

Calculation / Determination of Standard Time : This calculation can be used as a performance standard.

Work sampling can also be used to set standards, we can determine normal time as shown below and calculate standard time according to equation as mentioned above.

$$\text{Standard time} = \frac{a \times b \times c}{d} + \text{Allowances}$$

(or)

Standard time = (Observed time) (Rating factor) (1 + PF, Allowances)

(or)

= (Observed time) (Rating factor) + (Observed time) (Rating factor) (PFD Allowance)

Where :

a = Total study time in minutes.

b = Percentage working time/100.

c = Average performance rating/100.

d = Total production during the observation period.

9.2 INVENTORY CONTROL

Inventory refers to the stock of the products that a firm is offering for sale to produce final products. In other words, inventory is composed of assets that can be sold by the firm in the future causes of business operations.

Thus, inventory represents the last liquid current asset of a firm, which constitutes an important component of firm's balance sheet. Inventory could be in the form of raw material, WIP and finished goods that have been stored in warehouses.

9.3 TYPES OF INVENTORY MODELS

Economic lot size of an item depends on the following :

(1) Possibility of placing repeat orders.

(2) Nature of demand.

(3) Availability of discount.

(4) Single or multiple product manufacture.

Inventory models considering the above aspects can be classified as under :

(1) **Static Inventory Model :** It is applicable in case where only one order can be placed to meet the demand. Repeat orders are either impossible or too expensive. Typical examples of items under this group are, *perishable goods* like bread, vegetables etc, *seasonal products* like coolers, umbrellas, crackers, sweaters, rain coats etc.

(2) **Dynamic Inventory Model :** It is applicable for items where repeat orders can be placed to replenish stock. Dynamic inventory models can be classified as :

(i) Deterministic models.

(ii) Probabilistic models.

4.2.1.2 Delphi Technique / Expert Opinion Method

This method is also known as expert opinion method of investigation. In the method instead of depending upon the opinions of buyers and salesmen, firms can obtain views of the specialists or experts in their respective fields. Opinions of different experts are sought and their identity is kept secret. These opinions are then exchanged among the various experts and their reactions are sought and analyzed. The process goes on until some sort of unanimity is arrived among all the experts. This method is best suited in circumstances where intractable changes are occurring.

Wages and incentives:

Straight piece work system: In this system the worker is paid at a specified piece rate for the nor of pieces or units produced by him. The standard output is set and worker is guaranteed with a minimum wage. Thus if a worker produces less than the standard output he will get minimum guaranteed a wage. If another worker produces more than standard output. he is paid a wage in direct proportional to the nor of pieces produced by him at the specified piece rate.

Halsey plan: In this system, standard time is set from the past production records for the completion of a job. The worker is guaranteed a minimum wage. If the worker completes the job in the standard or more than standard time he is paid at his guaranteed time rate.

If a worker complete the job less than standard time he is paid a bonus in addition to his base wage at the guaranteed time rate. The amount of bonus varies from 30 to 50% of the time saved. The wages for job with

$$E = T \cdot R + \frac{S-T}{2} \times R$$

E = Total Earning

T → Actual time

S → Standar time

R → Base Rate.

<u>**Rowan Plan:**</u> In this system an hourly rate is guaranteed for the completion of job is established from the past production record. If the job completion is standard or more than the standard time the worker is paid the guaranteed wage. If the job is completed in less than the standard time the worker is paid a bonus in addition to basic wages.

$$E = T \times R + \frac{S-T}{2} \times R$$

plant location And plant layout

The plant layout is physical arrangement of building, machinery, equipment workplaces and other facilities of product in order to process the product in most efficient manner.

The main objectives of best layout are

-> integration
-> Minimum movements
-> Material handling
-> Smooth and continuous flow.
-> safe and improved Environment
-> Flexibility

These are 3 types of plant layout.

-> process layout: The process layout is also known as analytical layout. This type of layout is Employed where

a) low volumes of production is req

b) Similar jobs are manufactured on similar machines.

c) Machines are arranged on functional basis.

~~Merits~~ Drawbacks:

→ More floor space is req.

→ production control is more difficult and costly.

→ Routing and Scheduling is more difficult.

→ Handling and back-tracking of material is too much

Product Layout: The product layout is also known as synthetic layout. This type of layout is best suited where one type of product is produced and the product is standardised. This is used of mass production of the product.

Merits:

→ Lower overall manufacturing time

→ requires less space for placing machine

→ Utilises machines and labour better.

Drawbacks:

→ Specialised and strict supervision is req

→ and machined cannot used their

max. capacity

→ The manufacturing cost raises with the fall in the volume of production.

Eg: Automobile manufacturing.

Fixed position layout: Also called static product layout. In this location types of layout product cannot be moved from one location to another but tools, material and labour are moved to the product. This type of layout is used for manufacturing ships, aeroplanes, steam turbines etc.

Merits: It saves time and cost.

→ The layout is flexible as change in job design and operation sequence.

→ Adjustments can be made to meet the shortage of material of absence of workers.

the reorder po...

Sol D = 10,000 units / year

purchase price = Rs. 1 / item

C_o = Rs. 25 / order

C_c = 12% of the inventory value

C_c = ~~25 × 0.12~~ 1 × 0.12

$$EOQ = \sqrt{\frac{2DC_o}{C_c}}$$

$$= \sqrt{\frac{2 \times 10,000 \times 25}{0.12}}$$

$$= \sqrt{\frac{5,00,000}{0.12}} = \sqrt{4166,666.666}$$

= 2,042 units

Demand during lead time =

$$D_{LT} = \frac{10,000}{50} \times 4$$

$= 800$ units

no. of order / year $= \frac{10,000}{2042} = 49$ units

Re order point =

$$DLT = \left(\frac{D}{day}\right) \times LT \text{ in days}$$

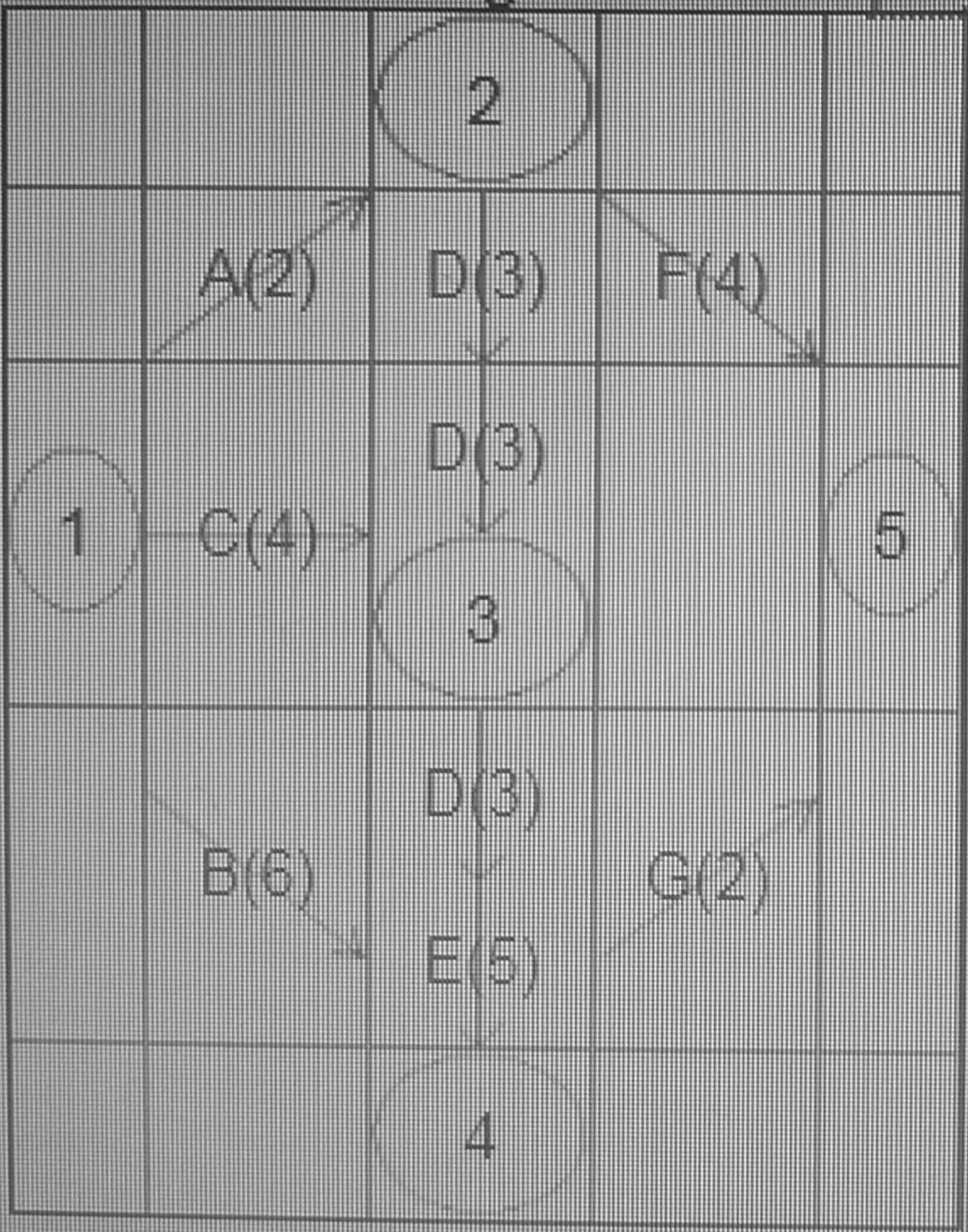
$$= \frac{10,000}{50} \times 28 \; (4 \times 7)$$

$$= \frac{10,00}{5} \times 28$$

$= 5600$ units (approx)

Scanned with CamScanner

The network diagram for the project, alon



Forward Pass Method

$E_1 = 0$

$E_2 = E_1 + t_{1,2}\ [t_{1,2} = A = 2] = 0 + 2 = 2$

$E_3 = E_1 + t_{1,3}\ [t_{1,3} = C = 4] = 0 + 4 = 4$

$E_4 = Max\left\{E_i + t_{i,4}\right\}[i = 1, 2, 3]$

$= Max\left\{E_1 + t_{1,4}; E_2 + t_{2,4}; E_3 + t_{3,4}\right\}$

$= Max\{0 + 6; 2 + 3; 4 + 5\}$

$= Max\{6; 5; 9\}$

$= 9$

$E_5 = Max\left\{E_i + t_{i,5}\right\}[i = 2, 4]$

$= Max\left\{E_2 + t_{2,5}; E_4 + t_{4,5}\right\}$

$= Max\{2 + 4; 9 + 2\}$

$= Max\{6; 11\}$

$= 11$

= 11

Backward Pass Method

$L_5 = E_5 = 11$

$L_4 = L_5 - t_{4,5}\ [t_{4,5} = G = 2] = 11 - 2 = 9$

$L_3 = L_4 - t_{3,4}\ [t_{3,4} = E = 5] = 9 - 5 = 4$

$L_2 = \text{Min}\left\{L_j - t_{2,j}\right\}[j = 5, 4]$

$= \text{Min}\left\{L_5 - t_{2,5}; L_4 - t_{2,4}\right\}$

$= \text{Min}\{11 - 4; 9 - 3\}$

$= \text{Min}\{7; 6\}$

$= 6$

$L_1 = \text{Min}\left\{L_j - t_{1,j}\right\}[j = 4, 3, 2]$

$= \text{Min}\left\{L_4 - t_{1,4}; L_3 - t_{1,3}; L_2 - t_{1,2}\right\}$

$= \text{Min}\{9 - 6; 4 - 4; 6 - 2\}$

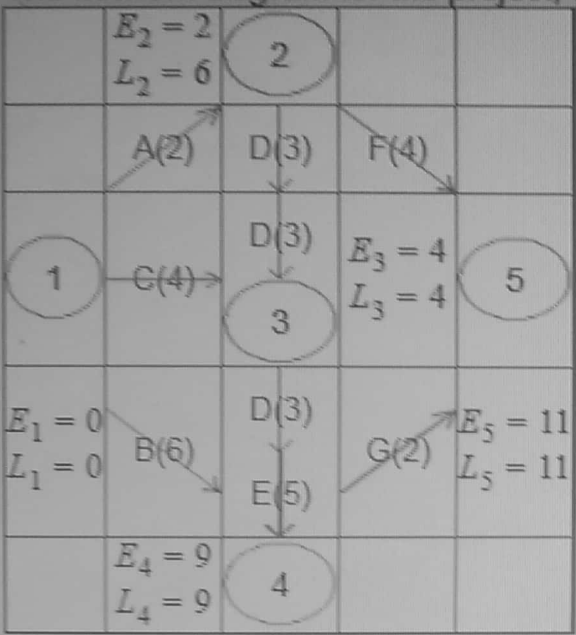
$= \text{Min}\{3; 0; 4\}$

$= 0$

The critical path of the project is : 1 - 3 - 4 - 5 and critical activities are *C, E, G*

The total project time is 11

The network diagram for the project, along with E-values and L-values, is



For each non-critical activity, the total float, free float and independent float calculations are shown in

Activity (i,j) (1)	Duration (t_{ij}) (2)	Earliest time Start (E_i) (3)	(E_j) (4)	(L_i) (5)	Latest time Finish (L_j) (6)	Earliest time Finish $(E_i + t_{ij})$ (7) = (3) + (2)	Latest time Start $(L_j - t_{ij})$ (8) = (6) - (2)	Total Flo $(L_j - t_{ij})$ - (9) = (8) -
1-2	2	0	2	0	6	2	4	4
1-4	6	0	9	0	9	6	3	3
2-4	3	2	9	6	9	5	6	4
2-5	4	2	11	6	11	6	7	5

Solution:

Expected time of each activity,

Activity	t_o	t_m	t_p	$t_e = \frac{t_o + 4 \cdot t_m + t_p}{6}$	$\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$
1-2	4	8	6	7	0.11
2-3	5	9	7	8	0.11
2-4	3	9	6	7.5	0.25
2-5	2	6	4	5	0.11
3-4	5	5	10	5.83	0.69
4-5	4	12	8	10	0.44
5-6	4	8	6	7	0.11

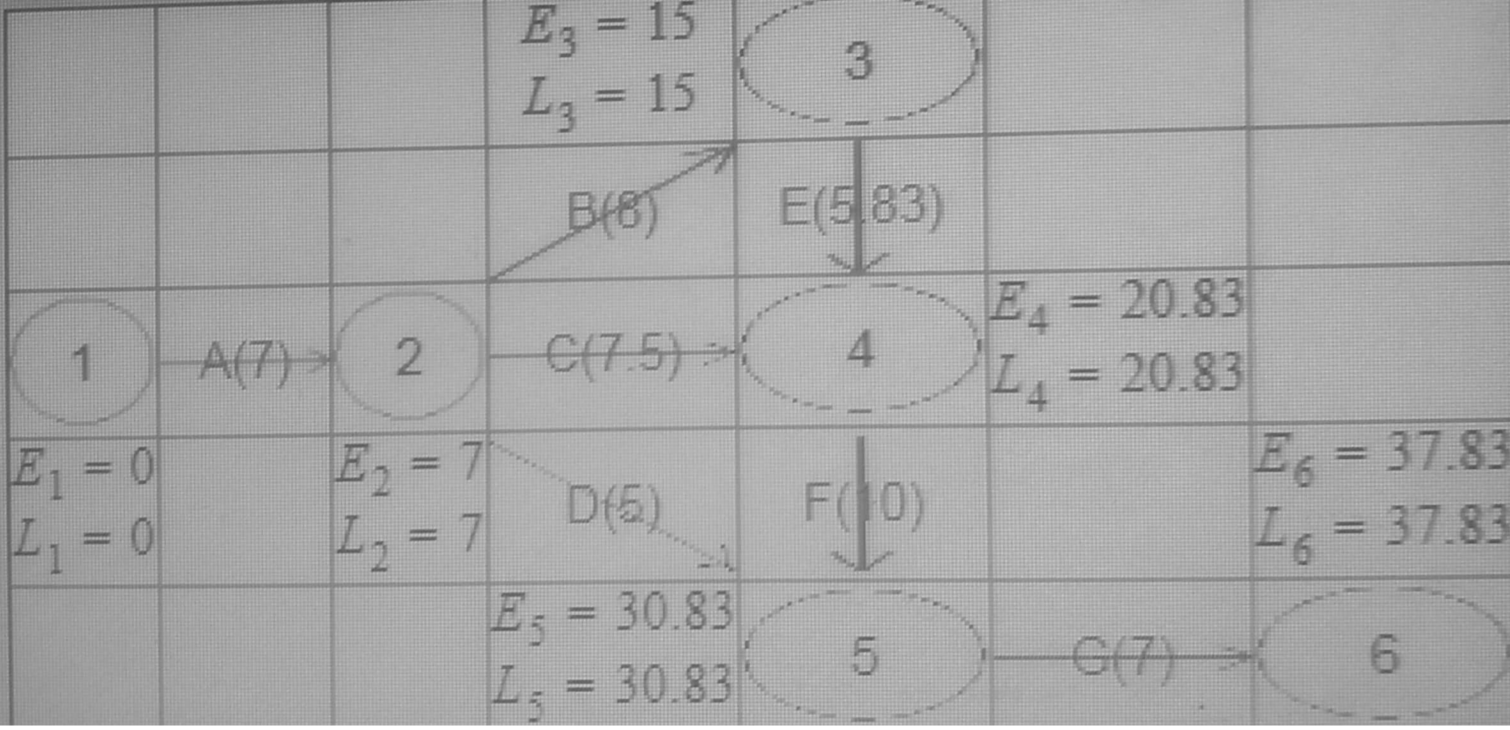
m is

Activity	Duration
1-2	7
2-3	8
2-4	7.5
2-5	5
3-4	5.83
4-5	10
5-6	7

receded and succeeded node

The total project time is 37.83

The network diagram for the project, along with E-values and L



Year (X)	Sales (Y)	$x = X - 5$	xy	x^2
1	6	-4	-24	16
2	8	-3	-24	9
3	11	-2	-22	4
4	23	-1	-23	1
5	29	0	0	0
6	34	1	34	1
7	40	2	80	4
8	45	3	135	9
9	56	4	224	16
(Σ) total	252	0	380	60

$\bar{x} = \frac{0}{9} = 0$

$\bar{y} = \frac{252}{9} = 28$

$b = \frac{380 - 9 \times 0}{60 - 9 \times 0 \times 0} = 6.33$

$a = \bar{y} - b\bar{x}$

$= 28 - 6.33 \times 0$

$a = 28$

$y = a + bx$

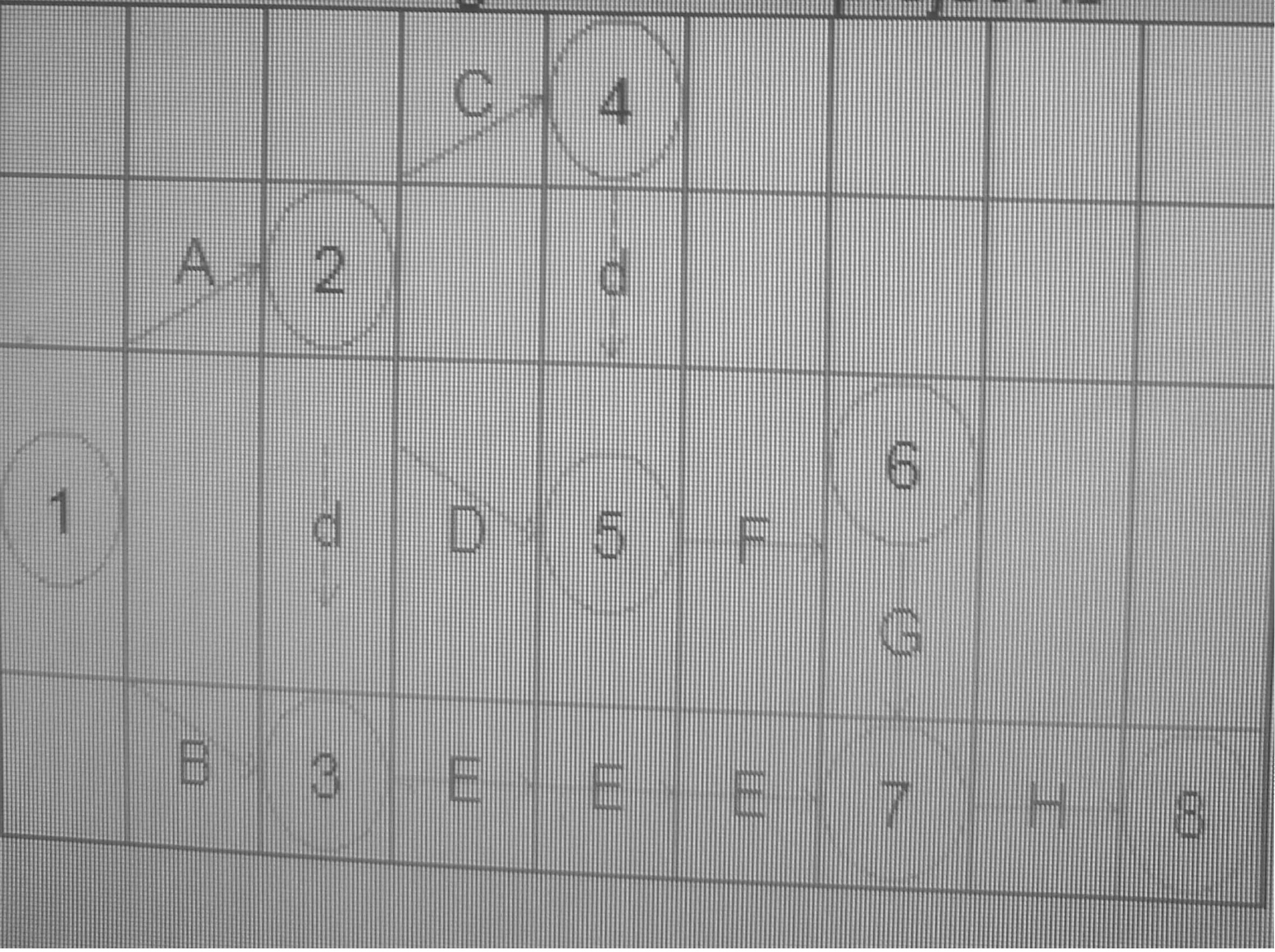
$y = 28 + 6.33x$ $\quad \because \left(x = X - 5\right)$

$y = 28 + 6.33(X - 5)$ $\quad$ forecast for year 10

$= 28 + 6.33(10 - 5)$ $\quad$ i.e. $X = 10$

$= 28 + 6.33 \times 5 = 60$ units

The network diagram for the project is



Input to MRP

MRP is a processor which inputs (Relating data) to give a phased detailed schedule for raw materials and components. These inputs are shown in Fig. 7.2.1.

(1) Master Production Schedule (MPS).

(2) Bill of Materials (BOM).

(3) Inventory Status File (ISF).

Which provides the information such as, inventory, status, replenishment lead times, and manufacturing lead time.

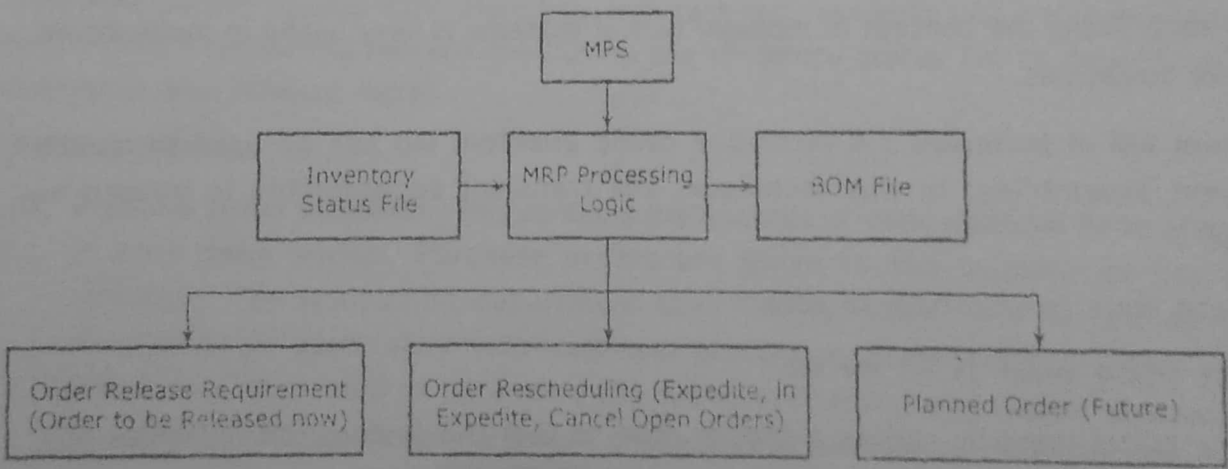


Fig. 7.2.1 MRP System

Master Production Schedule (MPS)

Note : Refer Section No. 6.2

Bill of Materials (BOM)

Bill of Materials (BOM) is a listing of all components (subassemblies and material) that go into an assembled item. It includes the part numbers and quantity required per assembly. The BOM provides the product structure hierarchy that guides the explosion process. If the BOM is inaccurate, the materials needed to manufacture an end item may not be available.

7.2.3 MRP Outputs

MRP provides variety of outputs that can be used as schedule of material for future time periods. The major outputs from and MRP system are shown in Fig. 7.2.4.

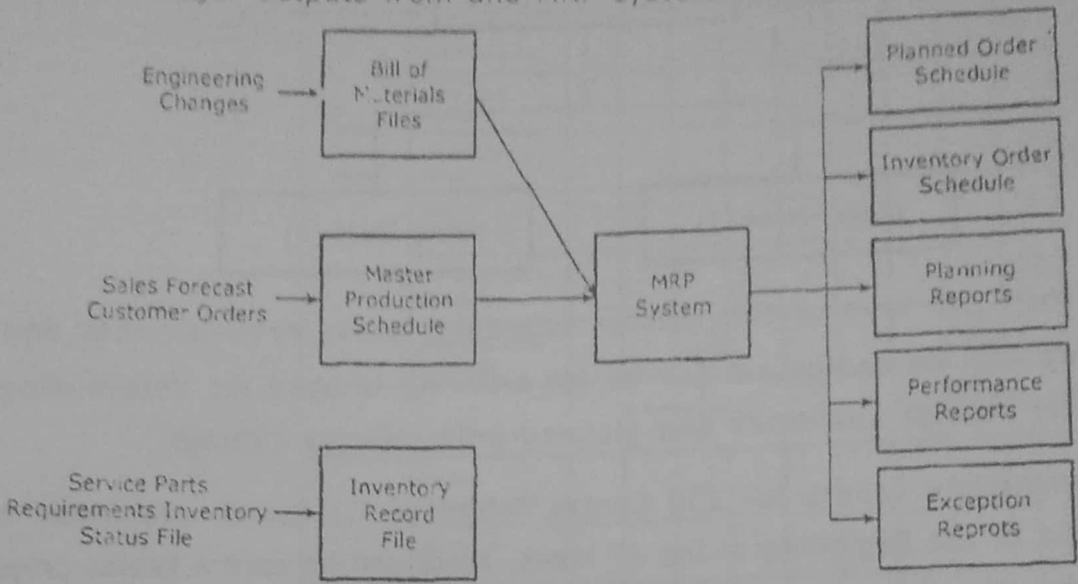


Fig. 7.2.4 MRP Operating System

The MRP output results from exploding end-item requirements into components with the help of bill of materials file and then using the inventory status file to determine net requirements and release dates :

(1) Primary Outputs

(i) **Planned Order Schedule :** This contains the quantity of each material to be ordered in each time period. Purchase orders are given to the supplier as per this schedule. The production department uses this schedule to order parts, sub-assemblies or assemblies from upstream production department. Planned order schedule is thus used to determine the future production and supply at suppliers end along with guide for in-house production schedule. By making due dates and need dates coincide, the MRP system keeps priorities valid.

(ii) **Order Release Notices :** Order release is used to place orders that have been planned.

(iii) **Rescheduling Notices :** Rescheduling notices indicates changes in ordered due dates needed to accommodate the proposed changes.

(2) Secondary Outputs

(i) **Planning Reports :** This pertains to future planning of inventory. Some examples are, purchase commitment reports, traces of demand sources, etc.

(ii) **Performance Reports :** MRP system provides management with valuable measure of performance. Some examples are, inventory turn over ratio, vendor rating Vendor Quality Rating (VQR), stock out index etc.

$$EBQ(\theta^*) = \sqrt{\frac{2 C_0 r}{C_e\left(1-\left(\frac{r}{k}\right)\right)}}$$

$$= \sqrt{\frac{2 \times 250 \times 36000}{25\left(1-\frac{36000}{72000}\right)}}$$

$$= \sqrt{\frac{2 \times 250 \times 36000}{25\left(1-\frac{36}{72}\right)}}$$

$$= \sqrt{\frac{18000000}{25\left(\frac{36}{72}\right)}} = \sqrt{\frac{18000000}{12.5}}$$

$$= \sqrt{1440000} = 1200/-$$

$$t_1 = \frac{Q^*}{k}$$

$$= \frac{1200}{72000} = \frac{1}{60} = 0.016 \text{ years}$$

$$= 0.2 \text{ months}$$

$$= 6 \text{ days}$$

$$t_2^* = \frac{Q^*}{r}\left(1 - \frac{r}{k}\right)$$

$$= \frac{1200}{36000}\left(1 - \frac{36000}{72000}\right)$$

$$= \frac{1}{30}\left(\frac{36}{72}\right) =$$

$$= \frac{36}{2160} = 0.016 \text{ years}$$

$$= 0.2 \text{ months}$$

$$= 6 \text{ days}$$

cycle time $= t_1 + t_2$

$6 + 6 = 12$ days