IEM - Industrial Engineering and Management.

Production results from man, material and machinery including tools and equipment together with some form of management (planning). They change the form or characteristics of the material or add another material to it to make a product.

Consists of a sequence of operations that transform the material from a given to a desired form.

Transformation by disintegration - Rolling, Extrusion, etc.
" " integration - assembly
" " services - transportation, loading/unloading (value additions)

Planning is the determinative phase of any product-management.

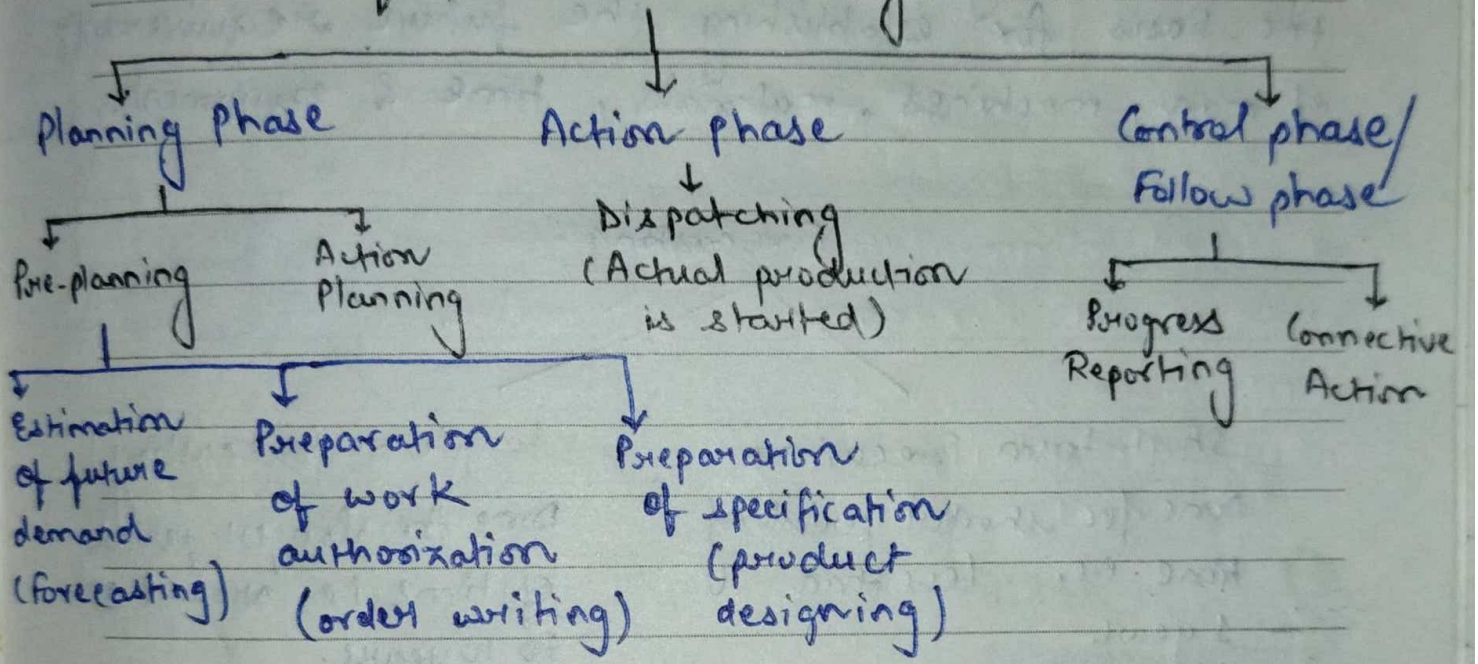
Involves two components - sales forecast, master production schedule (MPS), Production planning.

Production planning translates the sales forecast into MPS and prepares the req for materials, manpower and equipment and prepares detailed area of department schedules. Also determines maintaining of raw material & finished

goods at proper level.

Control is the regulative phase of product-management.

Functions of production Planning & Control



Action planning -

1) Preparation of work detail plan (process planning and routing).
2) Determination of the requirement- and control of material (material control)
3) Determination of the requirement- and control of tools (Tool control)
4) Determination of the requirement- and control of manpower (loading).
5) Scheduling.

1 APRIL 2015
Wednesday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Forecasting - It is defined as the estimation of future activity. It is the basis for the projection of work load into the future plan. This estimates of the type of a quantity of future work assignment- provide the basis for establishing the future requirement of man, machines, materials, time & equipment.

Forecasting

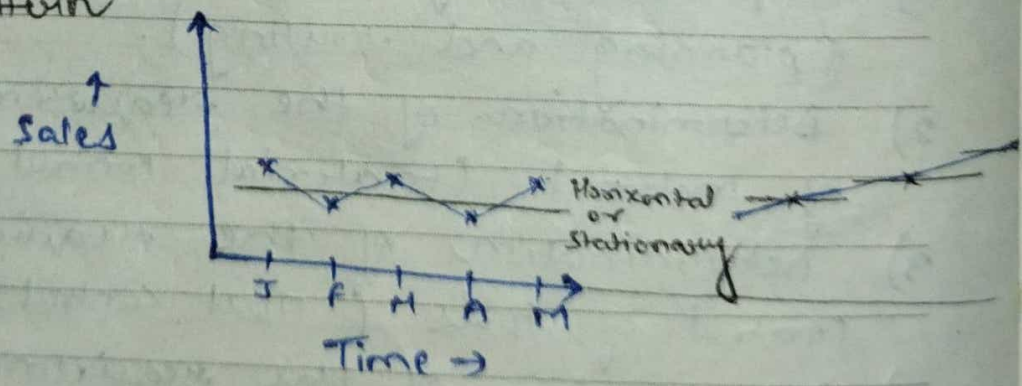
Short-term Forecasting
Done for shorter period of time i.e. less than 1 year.

Long-term forecasting
Done for longer period of time i.e. around 5 to 10 years.

2 APRIL
Thursday

Data Patterns -

1) Horizontal Pattern

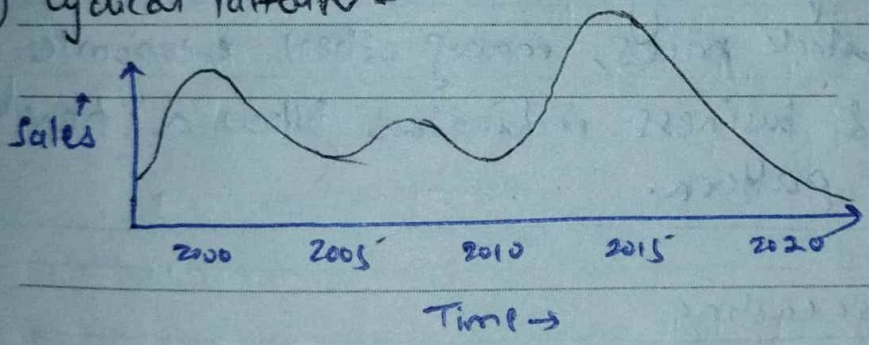


A horizontal pattern exists when there is no trend in the data i.e. it does not tend to increase or decrease in any systematic manner. The element of time is generally an important one in considering

HP. It may exist HP for short period of time but it shows some trend over longer period of time.

2) Seasonal Pattern - It exists when its reach fluctuates acc. to some seasonal factors, may be month or various seasons of the year. They could also be the days of a week or days in a month.

3) Cyclical Pattern -



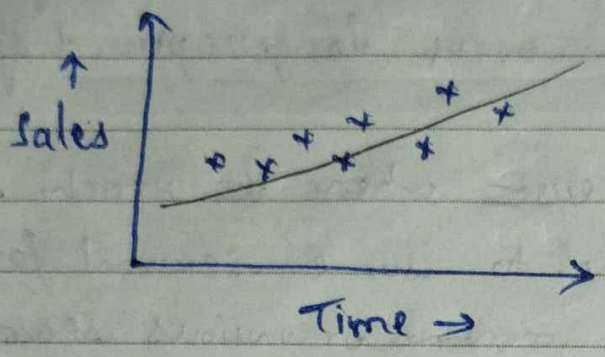
A cyclical data pattern items that follows cyclical patterns are prices of metals, gross national product, sales of many companies contains a cyclical pattern and it is the most difficult pattern to forecast because it does not repeat itself after a constant interval of time.

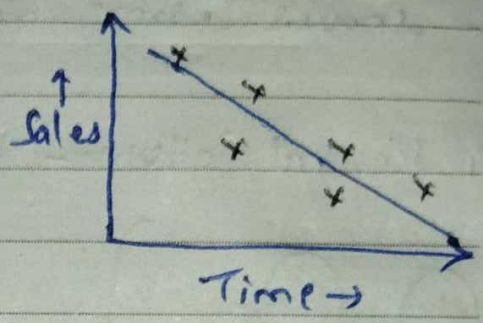
5 APRIL 2015
Sunday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

4) Trend Pattern





A trend pattern exists when there is a general increase or decrease in the value of the variable over time.

Eg: The sales of many companies, gross national product, stock prices, many other economic & business indicators follow a trend pattern.

6 APRIL
Monday

Techniques of Forecasting

1) Historical Estimate — Qualitative Method
2) Moving Average Method
3) Weighted Moving Average Method
4) Exponential Smoothing Technique
5) Regression Analysis.

} Quantitative Method.

2) Moving Average Method: $F_{t+1} = \frac{\sum_{i=1}^{n} x_i}{n}$

where, n = no. of data points.

Example

Time Period	Sales	
1	40	
2	45	
3	42	
4	50	5 (Most Recent)
5	56	
6	61	
7	66	
8	73	

$$f_{t+1} = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$= \frac{1}{5}(50 + 56 + 61 + 66 + 73)$$

$= 61.2$ (but it should have been more than 73)

So, this method is 'not suitable'.

So, it is taken care by next Method.

9 APRIL 2015
Thursday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

3) Weighted Moving Average Method:

$$f_{t+1} = \sum_{i=1}^{n} w_i x_i$$

$0 \leq w_i \leq 1$

where,

$$\sum_{i=1}^{n} w_i = 1$$

Now,

Time period	Sales x_i	w_i
1	40	0.05
2	45	0.05
3	42	0.05
4	50	0.1
5	56	0.15
6	61	0.15
7	66	0.2
8	73	0.25
		$\Sigma w_i = 1$

10 APRIL
Friday

0.1	4	— 50
0.15	5	— 56
0.2	6	— 61
0.25	7	— 66
0.3	8	— 73
$\Sigma = 1$		

so, $F_{t+1} = (0.1 \times 50) + (0.15 \times 58) + (0.2 \times 61) + (0.25 \times 66) + (0.3 \times 73)$

$= 64$ (but here also, we are giving the weightage randomly)

so, we go for ~~a~~ next Method.

---

4) Exponential Smoothing Technique: (Weightage in a certain specified order)

$$f_{t+1} = \alpha D_t + (1-\alpha) f_t$$

where,

f_{t+1} – ~~forecasting~~ forecasted value for $(t+1)^{th}$ period

F_t – forecasted value for t^{th} period

D_t – Actual sales value for t^{th} period

α – smoothing constant

$0 \leq \alpha \leq 1$

Time Period	Sales $x_i (D_t)$	F_t
1	40	
2		
3		
4		
5		
6		
7		
8		

13 APRIL 2015
Monday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

$\alpha = 0.4$

Time Period	Sales x_i (Dt)	F_t	F_{t+1}
1	40	40 (Assume)	F_1
2	45	40	$F_2 = 0.4 \times 40 + 0.6 \times 40 = 40$
3	42	42	$F_3 = 0.4 \times 45 + 0.6 \times 40 = 42$
4	50	42	$F_4 = 0.4 \times 42 + 0.6 \times 42 = 42$
5	56	45.2	$F_5 = 0.4 \times 50 + 0.6 \times 42 = 45.2$
6	61	49.52	$F_6 = 0.4 \times 56 + 0.6 \times 45.2 = 49.52$
7	66	54.1	$F_7 = 0.4 \times 61 + 0.6 \times 49.52 = 54.1$
8	73	58.8	$F_8 = 0.4 \times 66 + 0.6 \times 54.1 = 58.8$
			$F_9 = 0.4 \times 73 + 0.6 \times 58.8 = 64.5$

14 APRIL
Tuesday

MAY 2015

S	M	T	W	T	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

2015 APRIL 15
Wednesday

$\alpha = 0.7$

F_{t+1}

$F_1 =$

$F_2 = 0.7 \times 40 + 0.3 \times 40 = 40$

$F_3 = 0.7 \times 45 + 0.3 \times 40 = 43.5$

$F_4 = 0.7 \times 42 + 0.3 \times 43.5 = 42.45$

$F_5 = 0.7 \times 50 + 0.3 \times 42.45 = 47.7$

$F_6 = 0.7 \times 56 + 0.3 \times 47.7 = 53.51$

$F_7 = 0.7 \times 61 + 0.3 \times 53.51 = 58.75$

$F_8 = 0.7 \times 66 + 0.3 \times 58.75 = 63.8$

$F_9 = 0.7 \times 73 + 0.3 \times 63.8 = 70.2$

16 APRIL
Thursday

17 APRIL 2015

Friday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

MAY

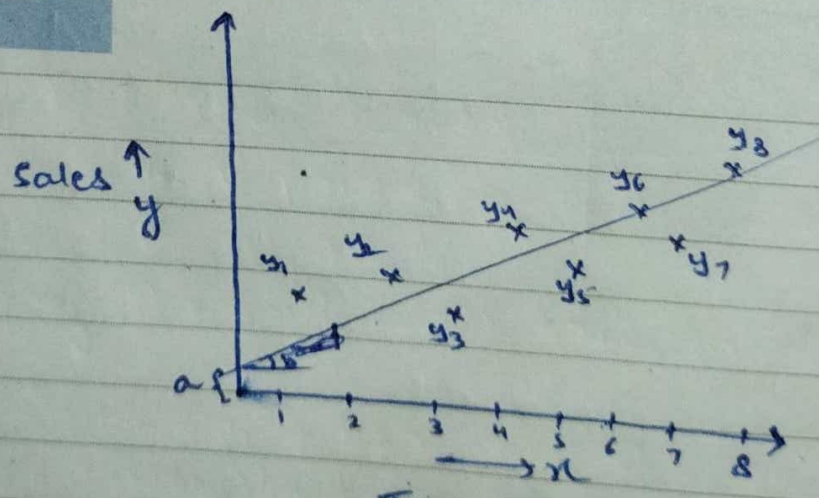
S	M	T
31		
3	4	5
10	11	1
17	18	1
24	25	2

Time Period	Sales x_i (D_t)	F_t	F_{t+1} at $\alpha = 0.4$
1	40	40 (Assume)	F_1
2	45	40	$F_2 = (0.4 \times 40) + (0.6 \times 40) = 40$
3	42	42	$F_3 = (0.4 \times 45) + (0.6 \times 40) = 42$
4	50	42	$F_4 = (0.4 \times 42) + (0.6 \times 42) = 42$
5	58	45.2	$F_5 = (0.4 \times 50) + (0.6 \times 42) = 45.2$
6	61	49.52	$F_6 = (0.4 \times 58) + (0.6 \times 45.2) =$ 49.52
7	66	54.1	$F_7 = (0.4 \times 61) + (0.6 \times 49.52) =$ 54.1
8	73	58.8	$F_8 = (0.4 \times 66) + (0.6 \times 54.1) =$ 58.8
			$F_9 = (0.4 \times 73) + (0.6 \times 58.8) =$ 64.5

18 APRIL

Saturday

5) Regression Method



Let $y_{ic} = a + bx_i$ —(1)

By Least Square Criteria, (The sum of the square of the differences b/w actual sales value & predicted sales value should be minimum)

f_{t+1} at $\alpha = 0.7$

F_1

$f_2 = (0.7 \times 40) + (0.3 \times 40) = 40$

$f_3 = (0.7 \times 45) + (0.3 \times 40) = 43.5$

$f_4 = (0.7 \times 42) + (0.3 \times 43.5) = 42.45$

$f_5 = (0.7 \times 50) + (0.3 \times 42.45) = 47.7$

49.52 $f_6 = (0.7 \times 56) + (0.3 \times 47.7) = 53.57$

54.1 $f_7 = (0.7 \times 61) + (0.3 \times 53.51) = 58.75$

58.8 $f_8 = (0.7 \times 66) + (0.3 \times 58.75) = 63.8$

64.5 $f_9 = (0.7 \times 73) + (0.3 \times 63.8) = 70.2$

Error $= S = (y_1 - y_{1c})^2 + (y_2 - y_{2c})^2 + \dots \Rightarrow$ minimum

$$S = \sum_{i=1}^{n} (y_i - y_{ic})^2 \Rightarrow \min.$$

$$S = \sum_{i=1}^{n} (y_i - a - bx_i)^2 \Rightarrow \min \quad \text{— (2)}$$

Now,

$$\frac{\partial S}{\partial a} \Rightarrow 2 \sum_{i=1}^{n} (y_i - a - bx_i)(0 - 1 - 0) = 0$$

$$-\Sigma y_i + na + b\Sigma x_i = 0 \quad \text{— (3)}$$

21 APRIL 2015
Tuesday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Now,

$$\frac{\partial S}{\partial b} \Rightarrow 2\sum_{i=1}^{n}(y_i - a - bx_i)(0 - 0 - x_i) = 0$$

$$\Rightarrow -\Sigma x_i y_i + a\Sigma x_i + b\Sigma x_i^2 = 0 \quad \text{— (4)}$$

Implementing (3) $\times \Sigma x_i$ — (4) $\times n$, we get-

$$-\Sigma x_i \Sigma y_i + na\Sigma x_i + b(\Sigma x_i)^2 = 0$$

$$-n\Sigma x_i y_i + na\Sigma x_i + nb\Sigma x_i^2 = 0$$

$$n\Sigma x_i y_i - \Sigma x_i \Sigma y_i = b\left[-(\Sigma x_i)^2 + n\Sigma x_i^2\right]$$

22 APRIL
Wednesday

So,

$$\left[b = \frac{n\Sigma x_i y_i - \Sigma x_i \Sigma y_i}{-(\Sigma x_i)^2 + n\Sigma x_i^2}\right]$$

Implementing (3) $\times \Sigma x_i^2$ — (4) $\times \Sigma x_i$, we get-

$$-\Sigma y_i \Sigma x_i^2 + na\Sigma x_i^2 + b\Sigma x_i \Sigma x_i^2 = 0$$

$$-\Sigma x_i \Sigma x_i y_i + a(\Sigma x_i)^2 + b\Sigma x_i \Sigma x_i^2 = 0$$

$$\Sigma x_i \Sigma x_i y_i - \Sigma y_i \Sigma x_i^2 = a\left[(\Sigma x_i)^2 - n\Sigma x_i^2\right]$$

MAY 2015

S	M	T	W	T	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

2015

APRIL 23
Thursday

So,

$$\left[a = \frac{\Sigma x_i \Sigma x_i y_i - \Sigma y_i \Sigma x_i^2}{(\Sigma x_i)^2 - n \Sigma x_i^2} \right]$$

Example

Time Period x_i	Sales y_i
1	40
2	45
3	
4	
5	
6	
7	
8	

APRIL 24
Friday

25 APRIL 2015

Saturday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Example

Time Period x_i	Sales y_i	$x_i y_i$	x_i^2
1	40	40	1
2	45	90	4
3	42	126	9
4	50	200	16
5	56	280	25
6	61	366	36
7	66	462	49
8	73	584	64
$\Sigma x_i = 36$	$\Sigma y_i = 433$	$\Sigma x_i y_i = 2148$	$\Sigma x_i^2 = 204$

26 APRIL

Sunday

Now,

$$b = \frac{n\Sigma x_i y_i - \Sigma x_i \Sigma y_i}{-(\Sigma x_i)^2 + n\Sigma x_i^2} \quad (n=8)$$

$$\Rightarrow b = \frac{8 \times 2148 - 36 \times 433}{-(36)^2 + 8 \times 204} = 4.75$$

and

$$a = \frac{\Sigma x_i \Sigma x_i y_i - \Sigma y_i \Sigma x_i^2}{(\Sigma x_i)^2 - n\Sigma x_i^2}$$

$$\Rightarrow a = \frac{36 \times 2148 - 433 \times 204}{(36)^2 - 8 \times 204} = 32.75$$

so, $y_{ic} = a + bx_i$

ie. $y_{ic} = 32.75 + 4.75x_i$

and $y_9 = 32.75 + 4.75 \times 9$

$= 75.5$

2nd function : Preparation of Work Authorization (Order Writting)

Work Authorization is defined as the authority given to an individual or group of individuals who undertake a specific task and this authority is given in written form known as order writting.

3rd function : Product Planning

→ Preparation of Specifications

Product Planning is defined as the extension of the original product design to information which can be used to plan the production process & purchase the materials which are required to make the final product.

29 APRIL 2015
Wednesday

MARCH 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

→ Extension of the original product-information

(1) In all activities, the product must be broken down into sub assemblies and component-parts. Product planner should utilize standard parts & assemblies to the greatest extent possible in order to reduce the total cost of the product-.

(2) The tolerances and specifications for each of the component parts and sub-assemblies must be established.

30 APRIL
Thursday

(3) The bill of materials is prepared for every product..

Action Plan for Previous Month

Process Planning

(i) Determination of most economical methods of performing an activity all process is considered known as process planning.

(ii) Determination of where the work is to be done, known as Routing.

Prerequisites of Process Planning -

Review 1) Volume of work should be done.
2) Quality of work required.
3) The equipment tools & facilities available to do the work.
4) The manpower available to do the work.
5) The schedule to show when the equipment tools & manpower will become available.

Steps in Process Planning

1) The process planner must list all of the work that needs to perform on a given product in terms of work element or sub operations.

Self Analysis

2) The process planner must group the work into operations based upon the capabilities of available equipment, available manpower, and volume of the final product to be processed.

3) The process planner must arrange the operations in the most economical sequence, taking into consideration what work must be performed first in order to control quality and maintain minimum operational cost.

Information generated as a result of Process Plan

i) The ~~of sequence~~ operations to be performed ← the sequence of operations.

for each operation, the following inf may be provided –

(a) Routing - for each operation, the dept. name and no. is to be listed for each operation and the alternative dept. name in which the operation can be performed.

(b) Instructions for performing the operations, particularly instructions are for manual operations such as machine speed, feed, welding currents, etc

(c) Tooling required.

(d) Manpower.

(e) Time requirement

2) Material Handling Procedure

(a) Type of equipment to be used to transport the material b/w the operations.

(b) Lot size - i.e. the quantity to be processed & moved b/w operations as integral units.

(c) ~~The~~ Type of containers to be used to store the material at the workplace and in which the material is to be placed when it is transported b/w operations.

Loading and Scheduling

~~loadi~~ Loading — Assignment of work to a facility. The facility may be people, equipment, work groups, or entire plant. Loading these facilities would consist essentially the assigning work task without specifying when the work is to be done or the sequence in which it is to be done.

Scheduling — Assignments of work to a facility and the specifications of the time and the sequence in which the work is to be done.
It is the time phase of Loading.

Informations req. for loading & scheduling
1) Sequence of operations required.
2) Routing
3) All informations about material.
4) Current shop situation.
5) Time standards for each operation
6) All informations about- tools.
7) Work Authorization

Loading and scheduling Techniques -
1) Master Production Schedule (Aggregate Planning)
2) Perpetual Loading
3) Order Scheduling
4) Loading by Schedule periods.

Aggregate Planning -

1 MAY 2015

Friday

APRIL

S	M	T	W	T	F	20
			1	2	3	
5	6	7	8	9	10	
12	13	14	15	16	17	
19	20	21	22	23	24	
26	27	28	29	30		

2 MAY

Saturday

JUNE 2015

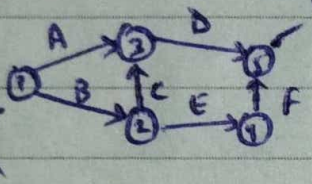
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

2015 MAY 3 Sunday

PERT Network

○ → Node - Event
→ – Activity
} 2 symbols used

[NETWORK]



Final/end event (only incoming activities present, no outgoing activities →○)

Nodes – 1, 2, 3, 4, 5

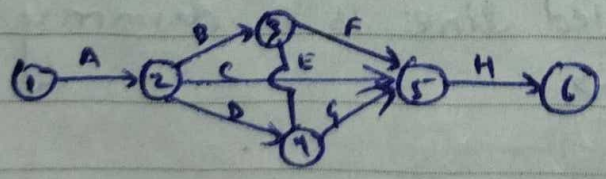
Activities – A, B, C, D, E, F

(Start event
or Initial event
(only outgoing activities present, no incoming activities)

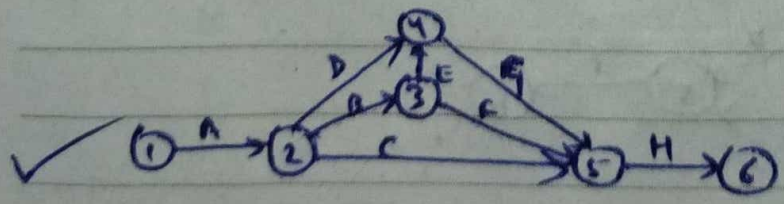
MAY 4 Monday

Rules for drawing the Network –

1)



X One activity should not cross another activity



✓

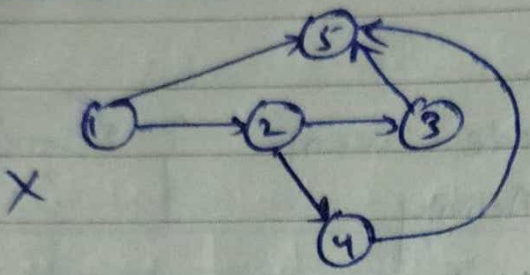
5 MAY 2015

Tuesday

APRIL 2015

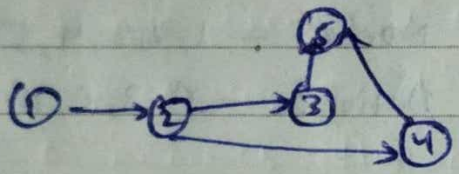
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

2)



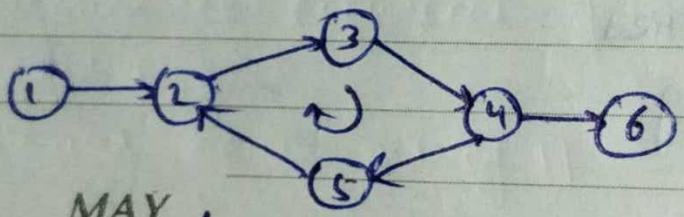
X

Activities should not be joined by a curved line, it should be a straight line.



✓

3)



Loop formation should be avoided.

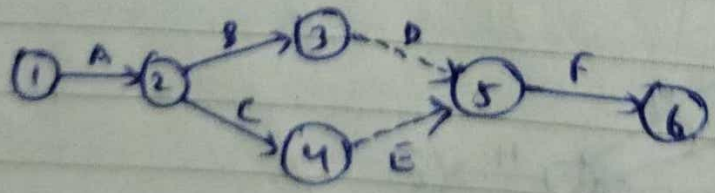
6 MAY

Loop formation

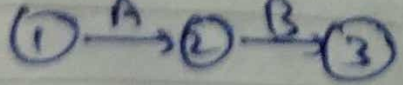
Wednesday

Note: Activities shown by dotted line is a dummy Activity. 1 - - - → 2

4)



X



Activity A is predecessor to Activity B

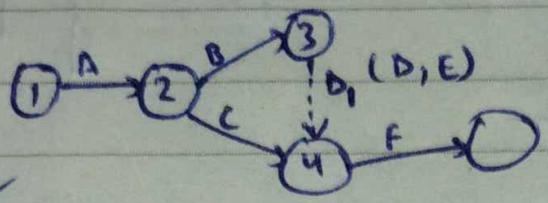
Activity B is successor to Activity A

JUNE 2015

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

2015 MAY 7

Thursday



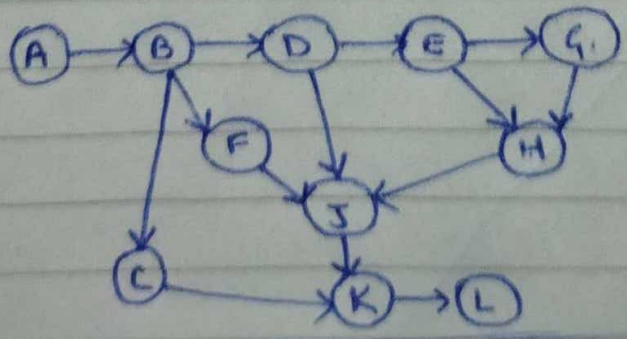
Minimum no of dummy activities should be used.

Question: Draw a network for the following project :-

Event No.	Preceded By (Start Event)
A	Start event-
B	A
C	B
D	B
E	D
F	B
G	E
H	G, E
J	D, F, H
K	C, J
L	K

8 MAY

Friday



9 MAY 2015

Saturday

APRIL

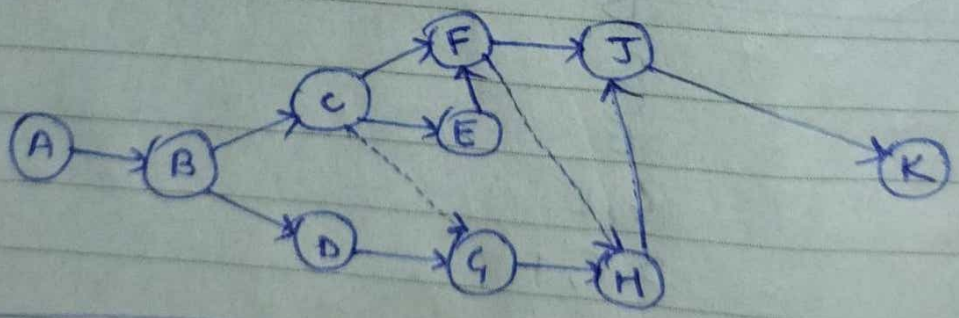
S	M	T	W	T	
			1	2	3
5	6	7	8	9	10
12	13	14	15	16	17
19	20	21	22	23	24
26	27	28	29	30	

Question - Draw a network for the following project.

A is the start- event
K is the final event
J is successor event of F
C and D are successor events of B
D is the preceessor event- to G
E and F occurs after C
E precedes F
C restrains the occurrence of G, G precedes H precedes J
F restrains occurrence of H
K succeeds J

10 MAY

Sunday



JUNE 2015

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

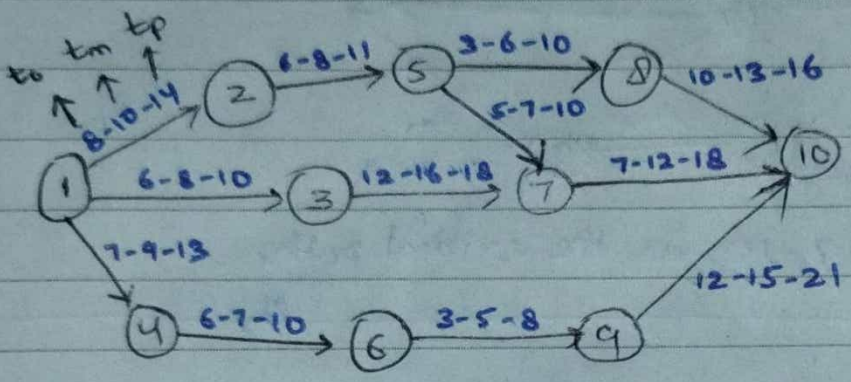
2015 MAY 15 Friday

Pert- Network

t_o - optimistic time

t_m - most likely time

t_p - pessimistic time



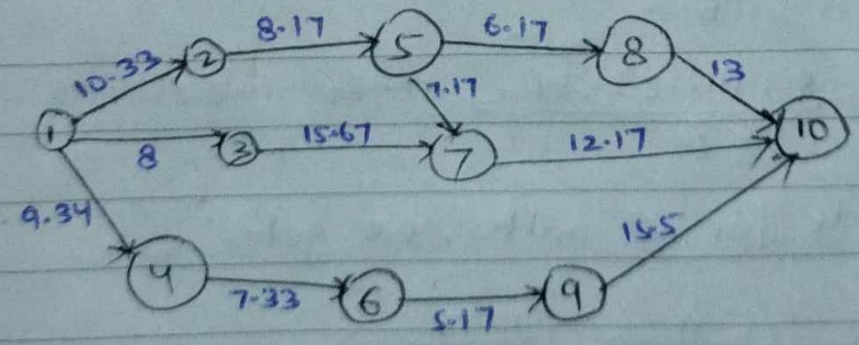
$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

expected time

$$t_e^{1-2} = \frac{8 + (4\times10) + 14}{6} = 10.33$$

MAY 16 Saturday

Calculating t_e for all paths, we get-



Path A: 1-2-5-8-10 — 10.33 + 8.17 + 6.17 + 13 = 37.67

Path B: 1-2-5-7-10 — 10.33 + 8.17 + 7.17 + 12.17 = 37.84 → Critical Path

Path C: 1-3-7-10 — 8 + 15.67 + 12.17 = 35.84

Path D: 1-4-6-9-10 — 9.34 + 7.33 + 5.17 + 15.5 = 37.34