Network diagram = Arrow diagram.

AMA.

Chapter 13 & 14.

CPM & PERT.

Difference :-

	CPM	PERT
→	activity oriented	Event oriented
→	Full form —	—
→	estimate of D —	3
→	Tool —	Planning
→	Difficulties —	—

control bom
time and cost.

1. Critical Path Method [CPM] : It is deterministic model & used for routine or repititive profects.

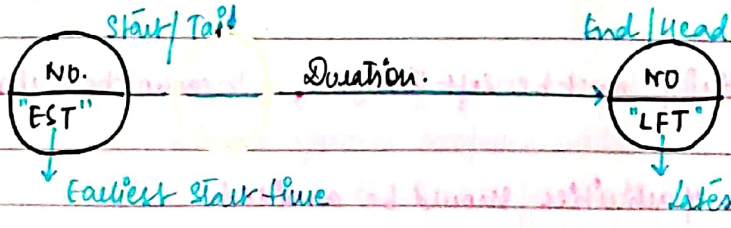
* ↳ Path whose Duration total is Max = Critical Path *

2. Programme Evaluation & Review Technique [PERT] :- It is a probabilistic model & used for new project/Unique project.

Above two techniques are used for timely & systematic execution of the project/Task.

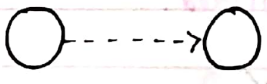
3. Following terms are important for understanding of CPM & PERT :-

Activity – It consumes time & resources, In a network flow of activity must be left to right, It can be represented as follows :-



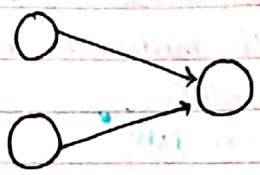
Event – It does not consume time & Resources, It is point of time.

Dummy Activity – It does not consumes time & Resources. It is drawn in the network to facilitate the network or to explain complicated relation of activities
Its duration is zero ["0"].
Used in unavoidable situations.

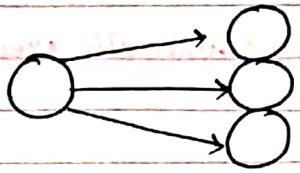


- An event must always come out of activity and terminate.
- Never leave any event dangling or alone; use dummy to connect it to the last. (except first & last event)
- Number from L to R (1 — 2).

Merging Event – It means an event where more than one activity finished/completed



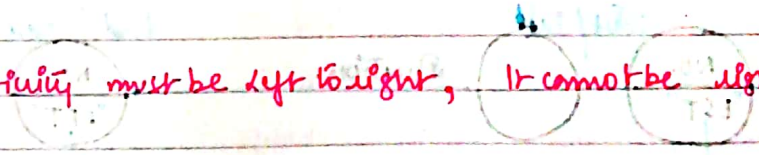
Bursting Event – It means an event from which more than one activity commence.



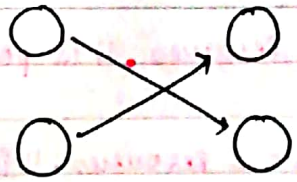
Network – Pictorial/diagrammatic presentation of logical relationship of various activities of a project.

4. Wrong Expression in Network :-

(i) Flow of Activity must be left to right, It cannot be right to left.

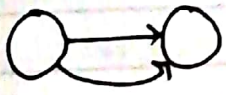


(ii) Intersection of activities should be avoided.

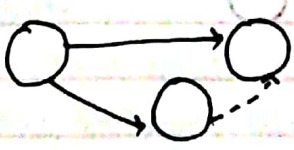


(iii) Looping of Activities should be avoided.

(iv) Duplicacy of activities should be avoided.



WRONG



RIGHT.

Note: Two activities starting from one point cannot be ended on same point. But if due to requirement of network, it is required, then it can end on the point with Dummy.

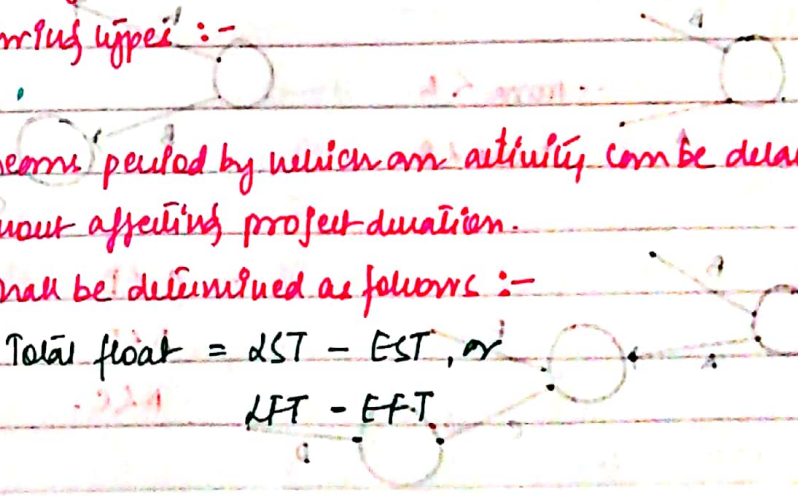
5. Determination of EST, LST, EFT, LFT of the project :-

(i) EST : It shall be determined with the help of network, for its determination, Foward Pass shall be used & at merging event, highest time shall be taken.

(ii) LFT : It shall be determined with the help of network, For calculation Backward Pass is used & at Busting event, Least time shall be taken.

(iii) EFT : EST + Duration. (iv) LST : LFT − Duration.

6. Float − It means period by which an activity can be delayed It may be following types :-



(i) Total Float − It means period by which an activity can be delayed without affecting project duration.
It shall be determined as follows :-
Total float = LST − EST, or
LFT − EFT

(ii) Free Float − It means period by which an activity can be delayed without affecting EST of immediately succeeding activity.
It shall be determined as follows :-
Free Float = Total Float − Head Slack.

(iii) Independent Float – It means period by which an activity can be delayed without affecting EST of immediately succeeding activity & LFT of immediately preceding activity.

∴ It shall be determined as follows:-

Independent float = Free Float – Tail slack

or

Total Float – Head slack – Tail slack.

(iv) Interfering Float – It means reduction in float of immediately succeeding activity due to use of float in any activity.

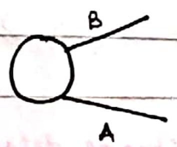
It shall be determined as follows:-

Interfering Float = LFT of the activity – EST of immediately succeeding activity

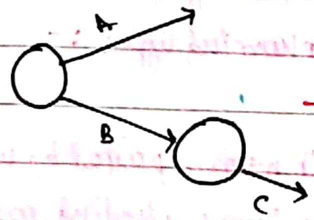
or

Head slack.

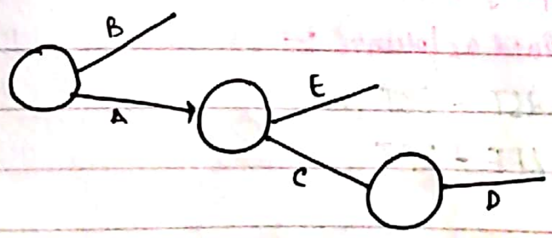
Symbol '<' is read as precedes



– none < A
none < B



– B < C



– C < D
A < F
A < C.

Jab kafe event se ek activity aur unke saath aur koi activity nikal rahi hain, use dummy, no limitation.

Concurrent activities mm diagram/network ladder ki tarah dikhna chahiye (Q → illustration 3 – page 13.15).

Never leave any activity open, end mm event se bind kar dena.

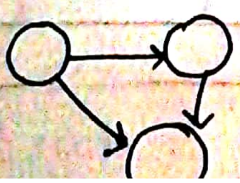
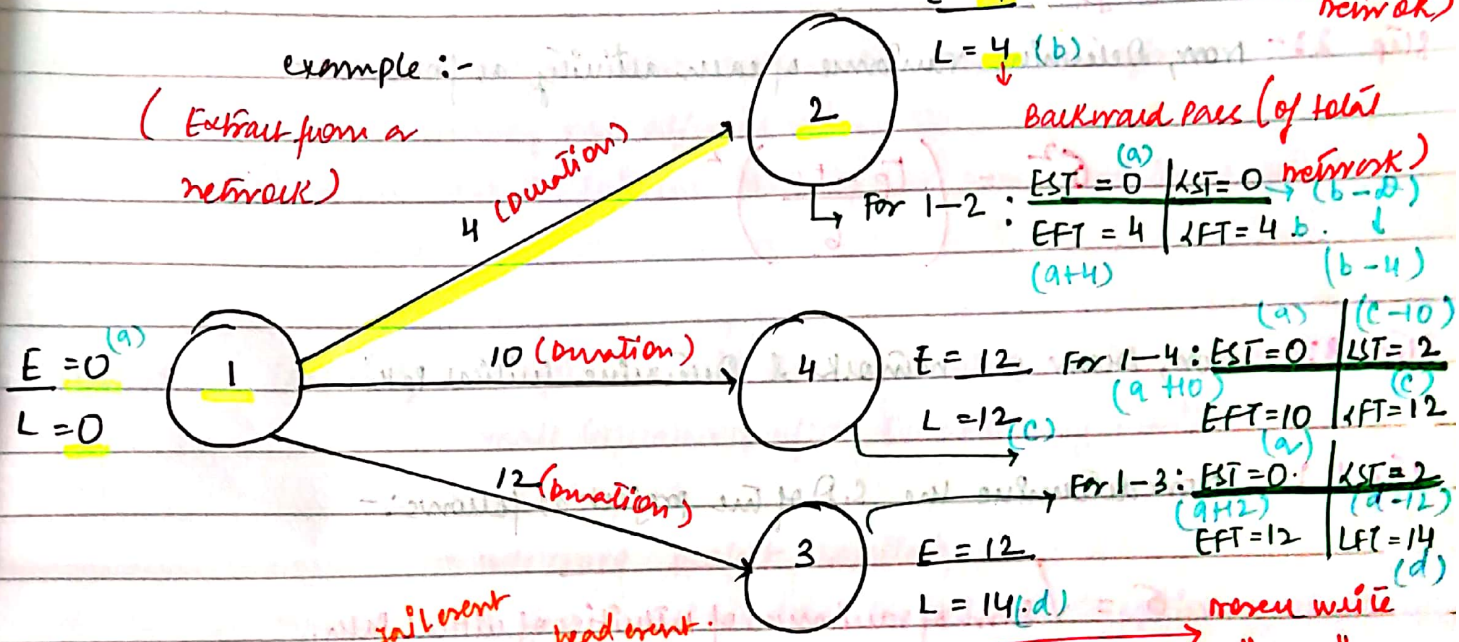


Illustration 6:-

1. When drawing a network, go for highest and lowest value timing for calculating E & L at each event.

2. But when for an activity calculate E & L, TF, FF, IF etc considering only that activity :-

example :-
(Extract from a network)



tail event
head event.

Activity :-

	1—2	1—4	1—3	
(a)				When write "-ve", reason of. (ix) if -ve write "0"
(i) EST (1)	0	0	0	
(ii) LST (4)	0 (ir-d)	2	2	
(iii) EFT (2)	0+4 (i+d) = 4	10	12	
(iv) LFT (3)	4	12	14	
(v) Slack of				
a — Tail event	0	0	0	} → EST - LST
b — Head event	0	0	2	} → EFT - LFT.
(vi) Total Float	0	2	2	} LST - EST.
(vii) Free Float	0	2	0	} vi - vb)
(viii) Interfering float	0	0	2	} TF - FF.
(ix) Independent float	0	2	0	} FF - iv(a).

→ Calculate from green per figures.

Q's — Illustration -3 ; Pg → 14.3.
" -4 ; Pg → 14.6.
" -6 ; " 14.10.
" -14 ; " 14.31.

Q1 → Page 14.12. (only *)
Q3 → " 14.15 (" ")
Q12 → " 14.38 (" ")
Q14 → " 14.43 (" ")
Q25 → " 14.70

4. Procedures under PERT :-

Step 1 :- Determine expected / mean time of each activity as follows :-

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

; t_o = optimistic
t_m = most likely
t_p = pessimistic.

t_e = duration of that activity (i-j)

Step 2 :- Now, Determine variance of each activity as follows :-

$$\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$$

Step 3 :- Now, Draw the network & Determine critical path.

Step 4 :- Now determine the S.D of the project as follows :-

$$\sigma = \sqrt{\text{sum of variances of activities of critical path.}}$$

Step 5 :- Now, determine "probability of completing the project" in specified duration as follows :-

↳ For not completing, yeh bola probability — 1 kar dena.

(i) Determine value of "z" as follows.

$$z = \frac{X - \bar{X}}{\sigma}$$

yeh, mean ka symbol, which = t_e = cp ka duration.

Here, X = Specified Duration
$\bar{X}$ = Project Duration.
σ = σ of project.

(ii) Now, Determine Table value of "z" (Table value always positive)

Look for "z" value in table mostly in 0.00 row; if z is -ve then deduct from positive value at z position.

If probability is given look for closest z value to that probability.

(iii) Now, determine probability for the specified duration. :

$P = .50 \pm$ Table value of "z" (If not cumulative table).

($P = .50 \pm$ table ka z ka value)

P = value of z in table

z = 1 ; P = .8413 } exceptions to above

z = -1 ; P = .1587 → 1 − .8413

Note :— (1) .50 will only be added or deducted when the given table value already not adjusted with .50

(2) If there are 2 critical Path, higher sum of variance will be taken.

Project Crashing :- After determination of project duration, efforts are made to reduce project duration by overtime working, etc.

- It is called project crashing.
- Project duration shall be reduced to optimum level with the help of following factors :
  - (i) reduction in fixed cost
  - (ii) ↑ in VC due to overtime working etc.
  - (iii) Reward / Bonus for early completion of the project
  - (iv) Penalty / Fine for delay in the project.

Project Duration	Crash cost	Direct cost	Indirect cost	Penalty	Total cost
x x	x x	x x	x x	x x	x x

(Indirect cost x new Duration)

→ optimum Duration → cost is minimum. (crash till it allowed)

→ minimum " → Time is minimum. (crash till it allowed)

4 For project crashing following procedure shall be used :-

Step 1:- Draw the network & determine critical path & other path along with duration.

Step 2:- Now, determine cost slope for each activity as follows :-

Cost slope (Crashing cost/day or week) = Increase in cost / Decrease in Time = Crash cost − Normal cost / Normal time − Crash time

Step 3:- Now, crash that activity of critical path which have least cost slope

Step 4:- When more than one path become critical, then make efforts to reduce all the paths simultaneously.

For example :-

1 — 2 — 5 — 7 = 19 days
1 — 3 — 4 — 7 = "
1 — 2 — 4 — 7 = "

} "When once of them fully crashed no further crashing can be done"

then crashing options are :-

1 — 2 & 1 — 3
2 — 5, 3 — 4 & 2 — 4
5 — 7, & 4 — 7
2 — 5 & 4 — 7
3 — 4 & 1 — 2

Always crash activity in critical path which has least crashing keeping in mind maximum crashes (normal time − crash time)

When all paths become critical, crash ek saath pair banna ke crash karna ↓ ∴ when only one path critical, then crash them separately as much as possible

When between 2 or more critical paths, there are common "critical activities" do not seperately crash them, crash common crash karne se no diff.

ex:- 1 — 2 — 4 — 5 — 6
1 — 2 — 3 — 4 — 5 — 6
1 — 2 — 5 — 6

→ Here, 5 — 6 common in all, don't crash it is of more.

project duration extended. ↑ reallocation and redistribution of resources, without

6. Resource Levelling & smoothing :- altering the project duration.

During project duration : Resource requirement fluctuate everyday, efforts are made to eliminate or minimise fluctuations in resource requirement with the help of float

Following procedures for it :- (Resource Levelling)

Step 1 : Draw the network & Determine Critical Path

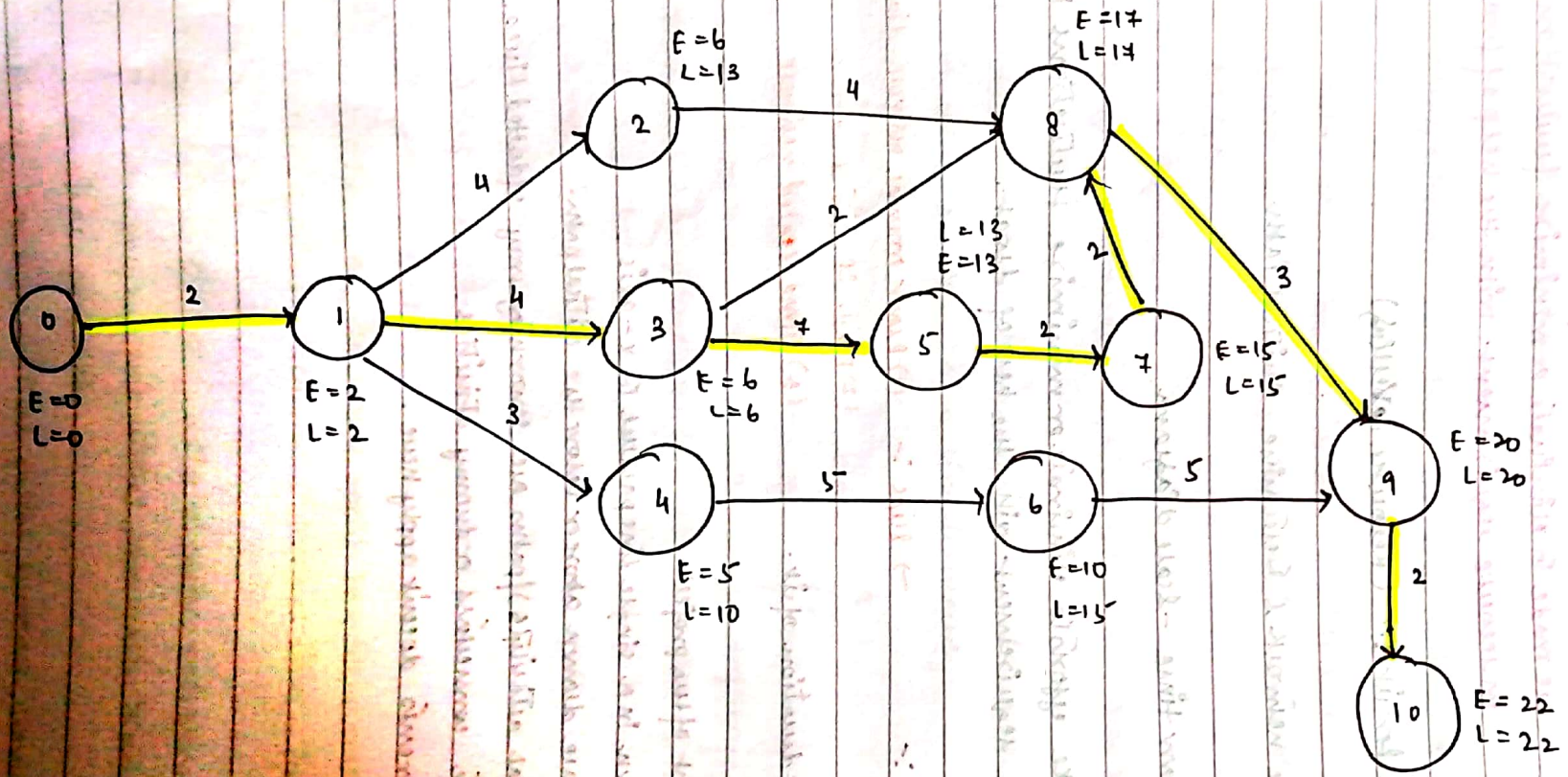
Step 2: now, Draw time - scale diagram

Step 3: now make efforts to eliminate or minimise fluctuations in resource requirement with the help of float.

#Time scaled network :- → Steps :- (1) Draw normal network diagram.
(2) Find CP & its duration
(3) Time scaled network

1) length of arrow = duration of it.
2) x axis = duration
3) y axis = First event of the project.
4) Critical path is drawn in a single line parallel to x-axis.
5) non critical paths are drawn above or below the critical path.
6) Floats in a non critical activity(s)/paths are shown by way of dotted lines.
7) vertical lines indicate connectors or dummy activities.
8) numbering rule of events doesn't apply here.

NETWORK DIAGRAM



Critical Path = 1 – 3 – 5 – 7 – 8 – 9 – 10

= 2 + 4 + 7 + 2 + 3 + 2 + 2

= 22 days.