PROJECT MANAGEMENT

NETWORK PROBLEMS

Network Problems Example

Gas Pipe connections
Water Pipelines
Infrastructure Projects
Book writing Project
Transportation Problem
Metro Stations
Planar Graphs
Social network
Computer Network

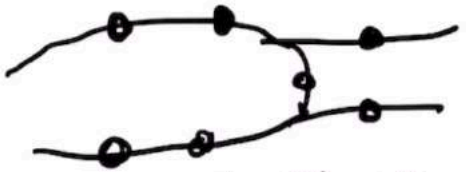
Network Problems: There are mainly two types of network problems

- Network Routing Problems
- Network Scheduling Problem

Network Routing Problems

(Path)

- Shortest route Alg.
  - Minimal Spanning tree
    - Maximal flow problem (Alg.
    - Minimum cut flow Alg.
      - Seven Bridge Problem



      - Euler Path / Hamiltonian / Graph Theory
        - Sensor Networks
          - Algo address to Social Network !!.

Project Management

- Network Scheduling Problem

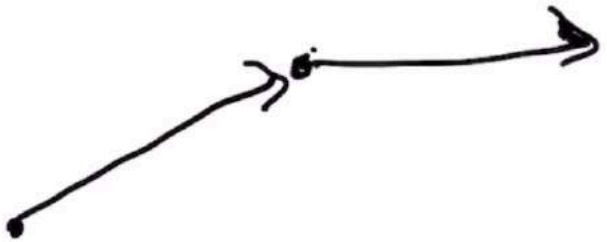
  Schedule (Time, Completion, cost)

  - Infrastruce Project
  - Write reasearch article
  - Write program.
  - . . . .

Example of a Project (Infrastructure Project)

Activities of the project

1. Clear the site
2. Survey and Layout
3. Rough Grade
4. Excavate for sewer
5. Excavate for electrical manhole
6. Install electrical manhole
7. Construct the boundary wall.



so on

Example of a Project (Book Writing Project/Research project)

Activities of the project

1. Manuscript reading by author
2. Sample pages prepared by the typesetter
3. Book cover Design
4. Preparations of diagrams used in book
5. Authors approval of sample pages
6. Book typesetting
7. Author's proof reading of typeset pages
8. Author checks artwork
9. Production of printing plates
10. Book Production and binding

Steps of Scheduling a Project

Flyover :

- Identify Activities ✓
- Identify activities dependencies ✓
- Identify network to execute the project ✓
- Identify Resource Optimization

To do above

We start representing project as a network comprised of activities and analyze the network to understand the time /cost optimization.

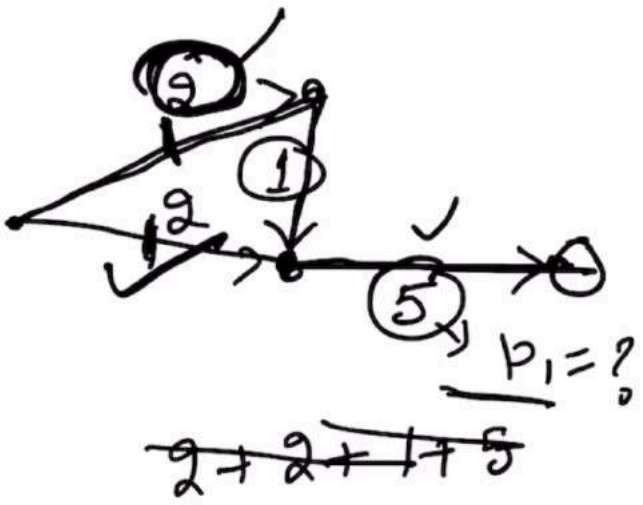
Example of a Project (Book Writing Project/Research project)

Activity	Activity Description	Predecessor Activity	Duration(days)
A	Manuscript reading by author	-	5
B	Sample pages prepared by the typesetter	-	3
C	Book cover Design	-	4
D	Preparations of diagrams used in book	-	7
E	Authors approval of sample pages	A,B	3
F	Book typesetting	E	5
G	Author's proof reading of typeset pages	F	2
H	Author checks artwork	D	2
I	Production of printing plates	G, H	3
J	Book Production and binding	C,I	7

Now represent above project as a network comprised of given activities and analyze the network to understand the time completion of project.

Project Management

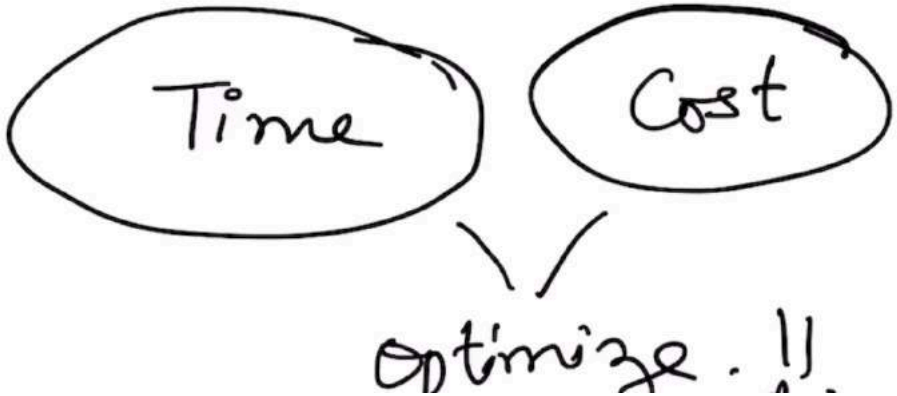
- CPM (Critical Path Method) → Deterministic Model.
- PERT (Program Evaluation and Review Technique → Probabilistic Model.



~~2 + 2 + 1 + 5~~

2 + 1 + 5

RAM → Review Analysis of Multiple Project.



Example of a Project (Book Writing Project/Research project)

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I	Production of printing plates	G, H	3
J	Book Production and binding	C,I	7

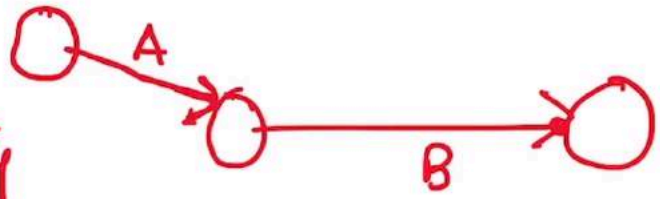
Now represent above project as a network comprised of given activities and analyze the network to understand the time completion of project.

Basic Components :→

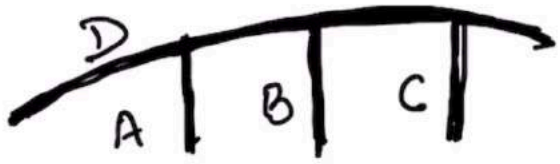
- Activity →
- Node (Event)

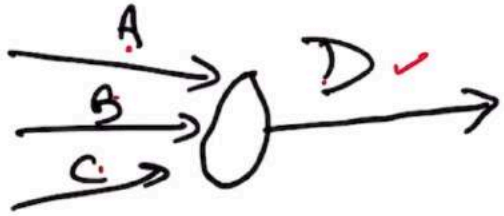
↓ start End

↳ completion ↘



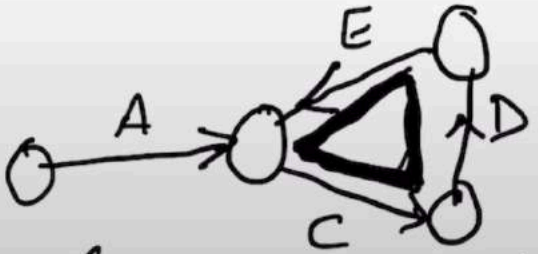
- Preceding Activity
- Sucessor Activity





Error

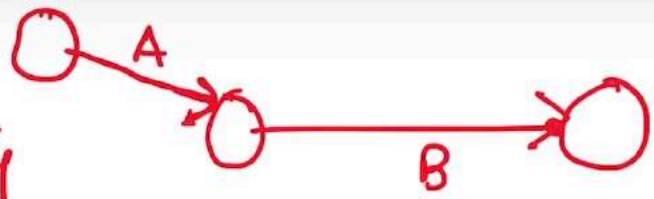
- Loop (Network are not comprised of loop

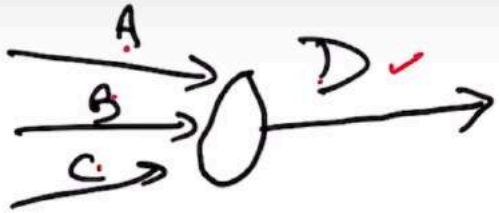


(Not Allowed!!)

- Dangling (Incomplete join of an activity

↳ completion ↘

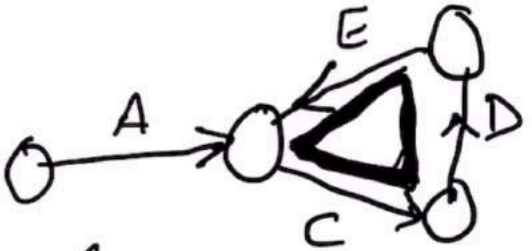




- Preceding Activity
- Sucessor Activity

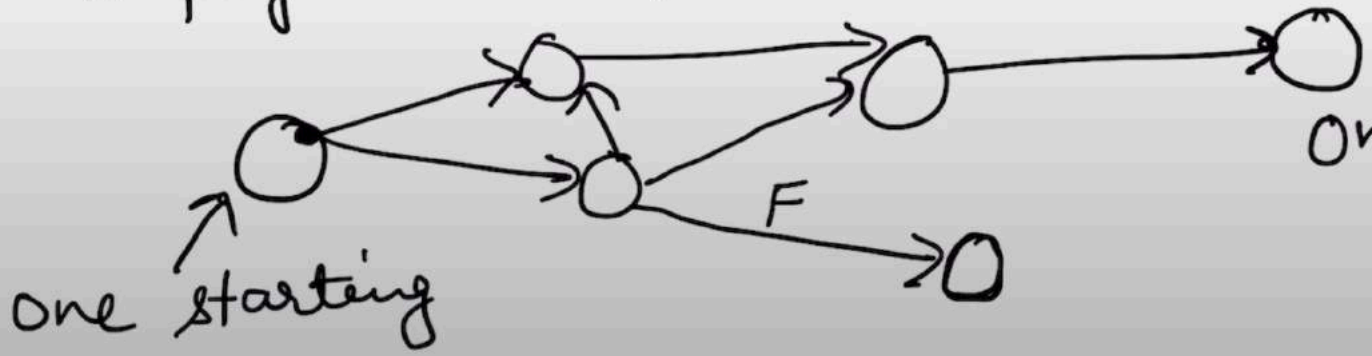
Error

- Loop (Network are not comprised of loop (Not Allowed!!)



- Dangling (Incomplete join of an activity)

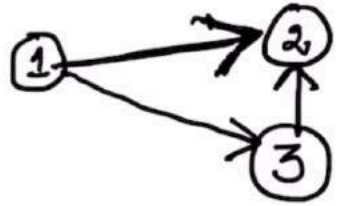
A project start from one node and finish at one node.



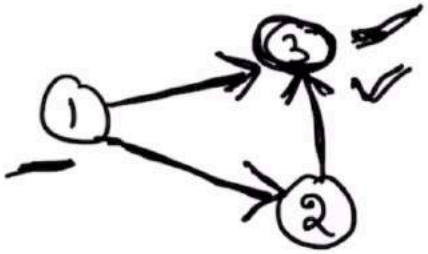
(Not Allowed!!)

Rules of Network Construction

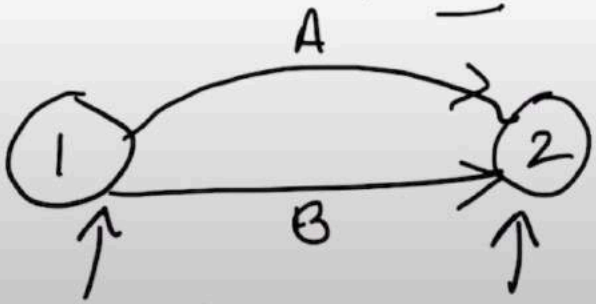
1. Each activity is represented by one and only one arrow.



2. start and End node must be identified.
3. Nodes should be labelled.
4. Between any pair of nodes; there should be only one activity



Or two nodes cannot have simultaneous start or simultaneous end.



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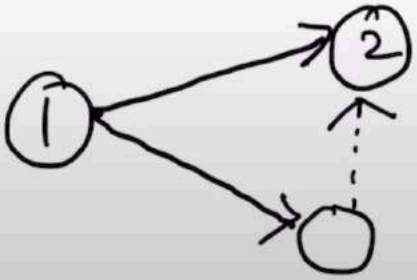
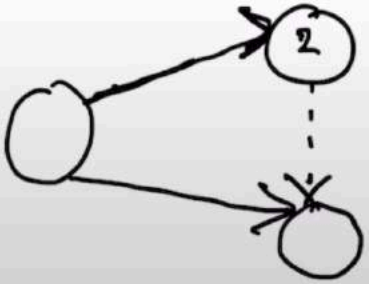
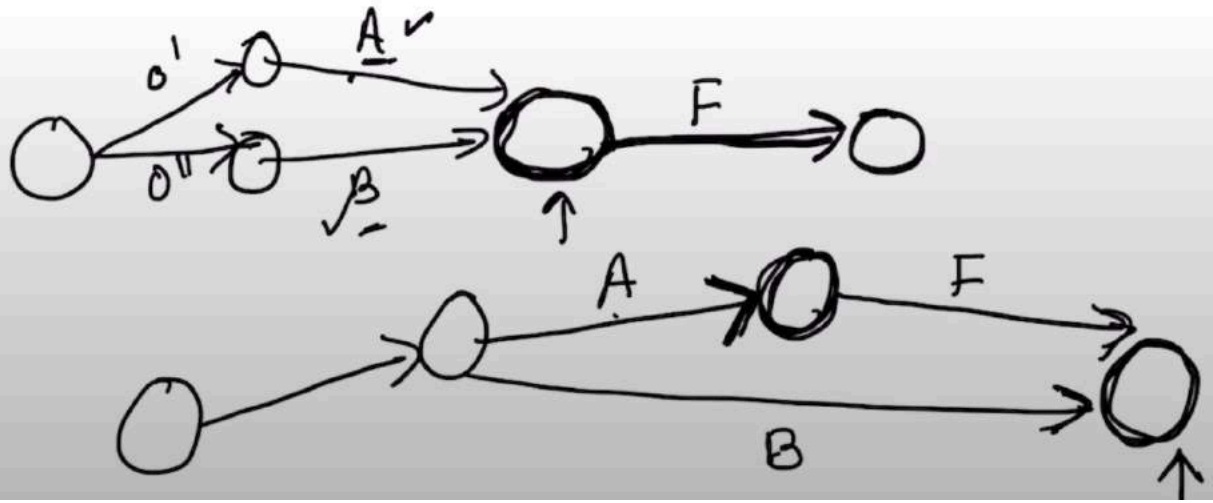




5. Arrows should be straight

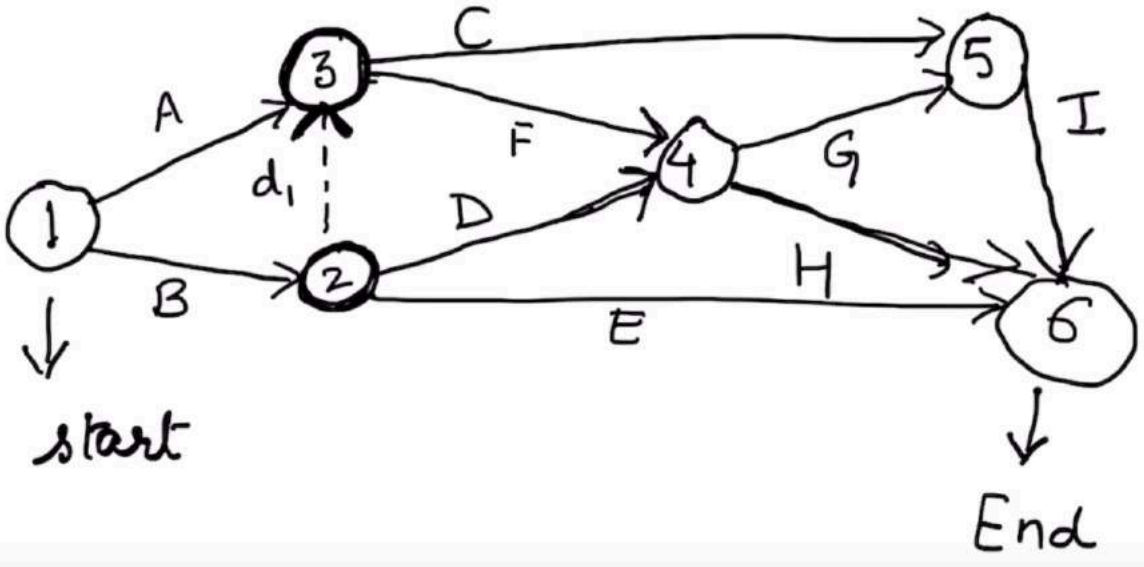
6. • An event cannot occur until all incoming activities into it have been completed.
   • An activity cannot start unless all the preceding activities on which it depends, have been completed.
   • Dummy activities should only be introduced if absolutely necessary.



(any activity we start from here have anything

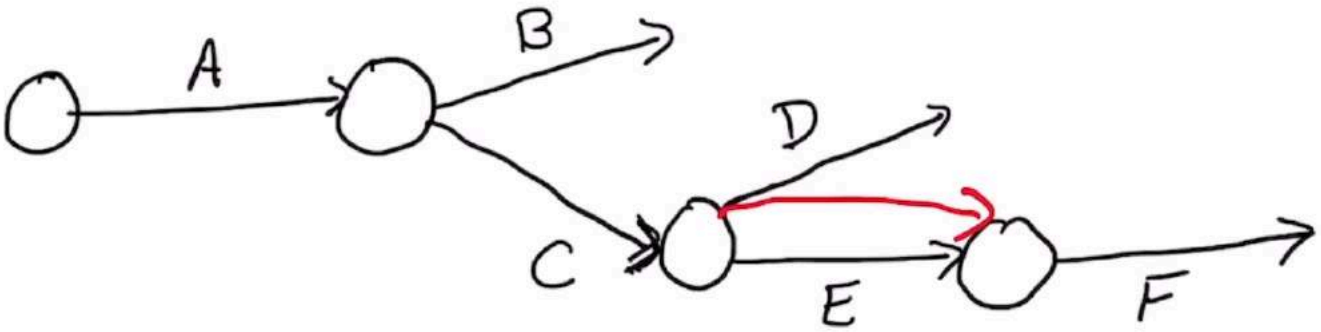
Example 1: Consider a project having some activities ; the activities list and their preceding activities list is given below:

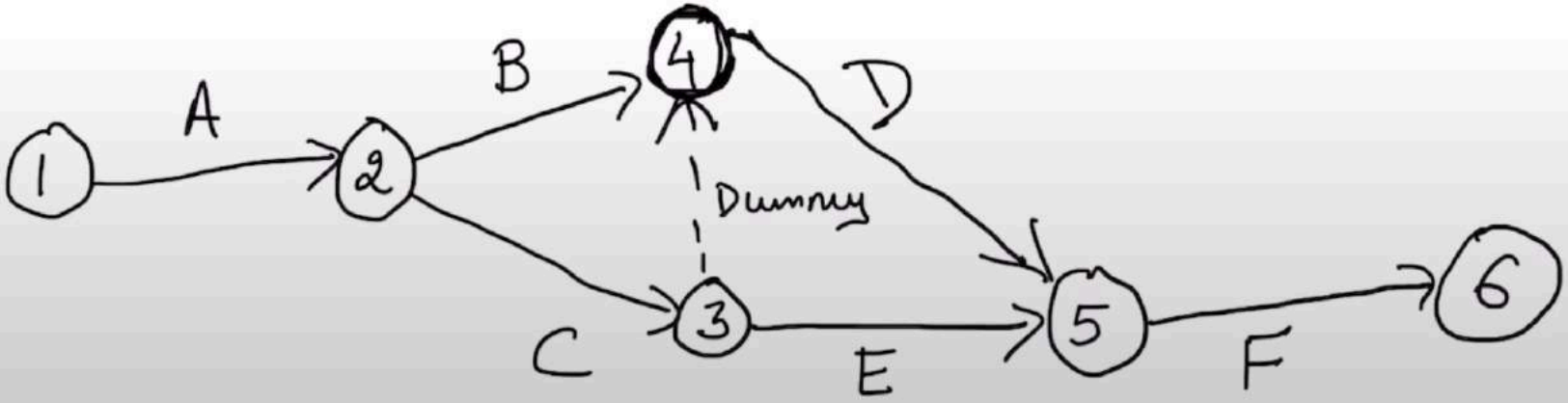
- A, B are starting activities
- A, B precede C
- B precede D and E
- A and B precede F
- F and D precede G & H
- C and G precede I
- E, H and I are terminal activities



Example 2 : Project : A is starting activity and precede B and C,

- C precedes D and E,
- F follows E and D is precedor of F
- B precedor of D

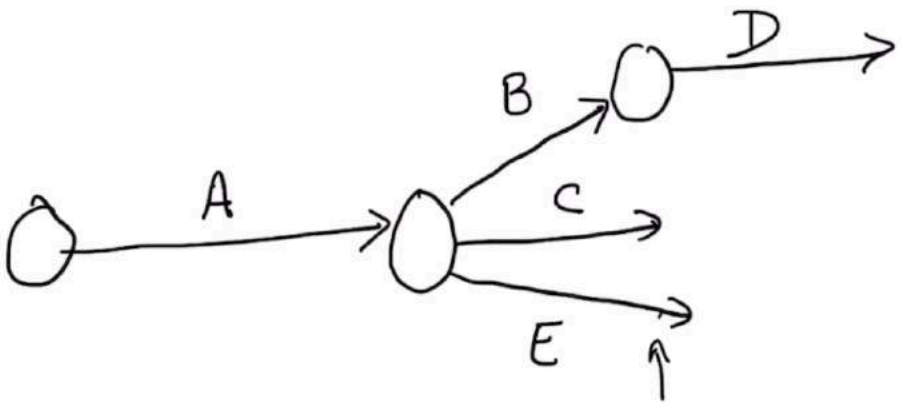


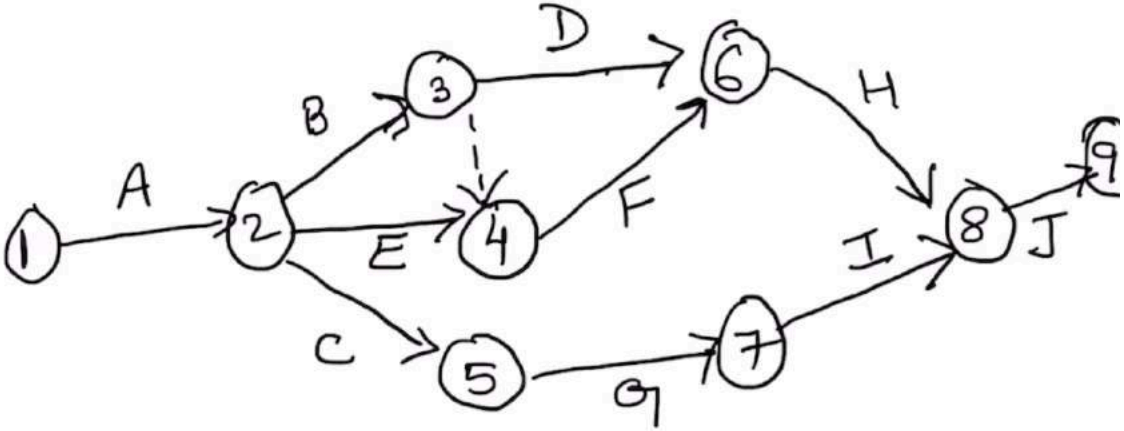


Example : Project:

Activities :	A	B	C	D	E	F	G	H	I	J
Preceders :	—	A	A	B	A	B, E	C	D, F	G	H, I

Draw a network to given project.





Calculating Completion time of a project (Critical Path Analysis)

Sunday, 26 April 2020 8:15 AM

In Previous video;

- What is Project ✓
- Activities | Preceding activities in Project ✓
- Construction of Network (Drawing) ✓

In this video;

- Total duration (Completion time of a Project)
- Identify activities of project as critical or non-critical activities
- Identify Critical Path
- Introduction to Crashing in Critical Path activities to further optimise the results as per requirement or need.

25 days.!!

Define: For any activity, we define;

- Earliest occurence time (starting time) of event i $= Es_i$
- Latest occcurence time (completion time) of event j $= Lc_j$

Notation.

time duration of an activity (i, j) $= t_{ij}$

We use following technique to calculate Es_i

- Forward Pass Calculation to find Es_i

Set $E_1 = 0$

$E_2 = E_1 +$ time taken by next activity (all events) — choose maximum

$\vdots$

$E_i = \max \{ E_{i-1} + t_{ij} \}$

Example 1: consider the project;

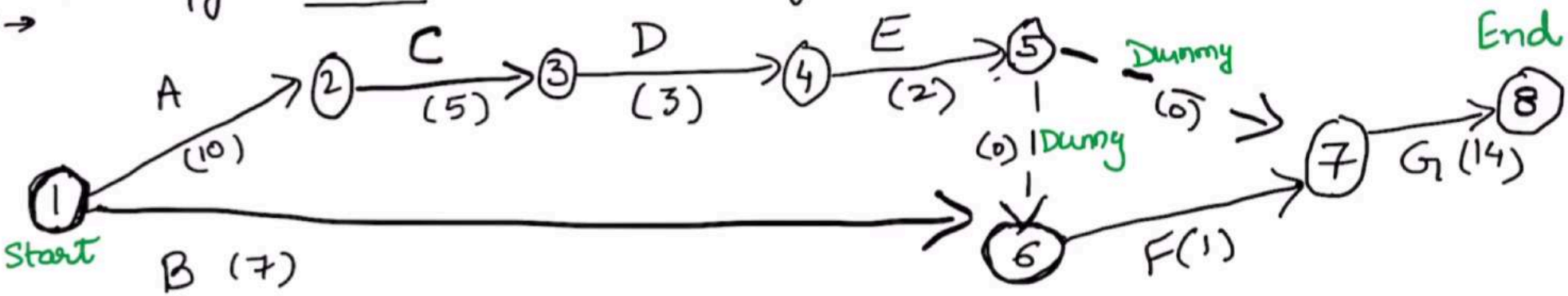
Activity	A	B	C	D	E	F	G
Preceding activities	—	—	A	C	D	B, E	E, F
Time (Duration) (in days)	10	7	5	3	2	1	14

(i) Construct the network

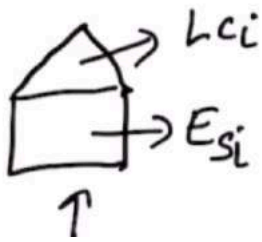
(ii) Identify Earliest time occurence of each event.

Solution:→

(i)



Notation:

(E_{si}, L_{ci}) or  or E_{si} = L_{ci} =

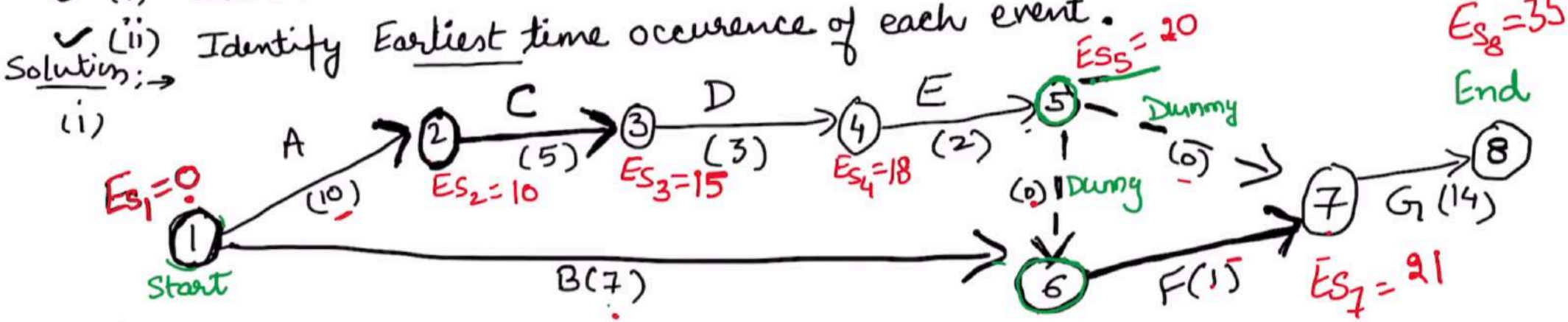
Activity	:	A	B	C	D	E	F	G
Preceding activities	:	—	—	A	C	D	B, E	E, F
Time (Duration) (in days)	:	10	7	5	3	2	1	14

(i) Construct the network

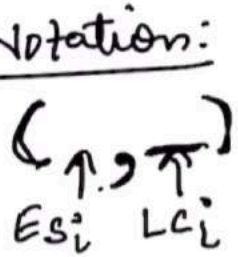
(ii) Identify Earliest time occurence of each event.

Solution:→

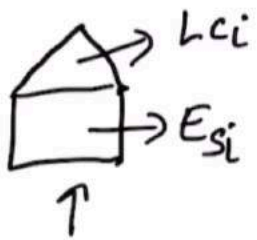
(i)



Notation:



or



or

Esi =

Lci =

Text Mode | Lasso Select | Insert Space

We use following technique to calculate LC_j

Completion.

- **Backward Pass Calculation to find LC_j**

  Set $L_l = E_l$; l – subscript stand for Last node.

  and to compute latest occurrence times of event i $(i<j)$; subtract duration of each activity from lastest finish time of the activity.

  that is $L_i = \min_j \{ L_j - t_{ij} \}$

Forward and Backward Pass Calculations ensures

- $E_1 = L_1$; subscript 1 → stand for first Node
- $E_l = L_l$; subscript l → stand for last Node

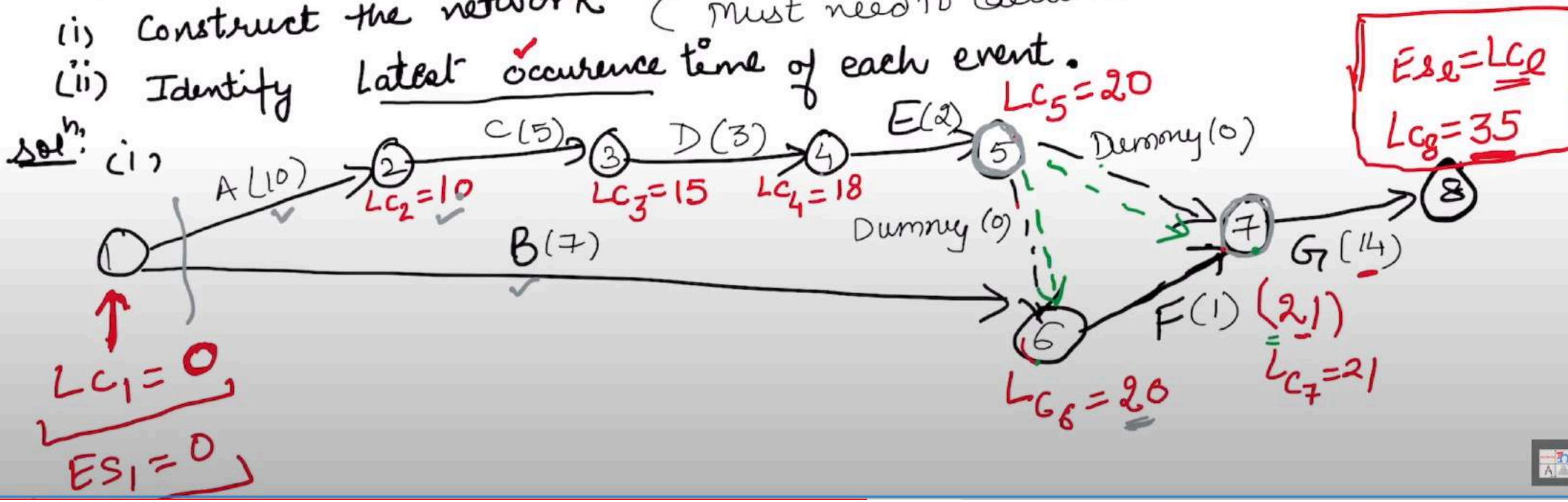
Example 2 : consider the project ;

Activity	:	A	B	C	D	E	F	G
Preceding activities	:	—	—	A	C	D	B, E	E, F
Time (Duration) (in days)	:	10	7	5	3	2	1	14

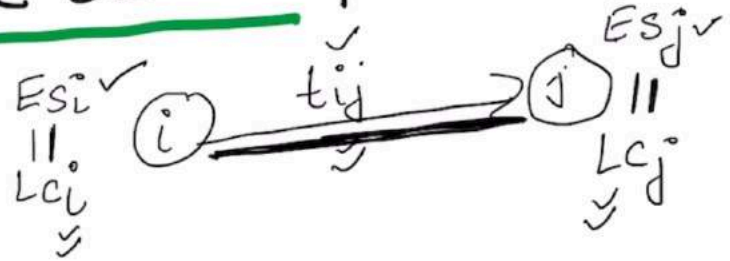
(i) Construct the network (must need to calculate Earliest time)

(ii) Identify Latest occurence time of each event.

Soln: (i)



Critical Activity: An activity (i, j) will be critical if it satisfies following



(i) $Es_i = Lc_i$

(ii) $Es_j = Lc_j$

(iii) $Es_j - Es_i = Lc_j - Lc_i = t_{ij}$

If any one of above condition is not satisfied then it is a non-critical activity.

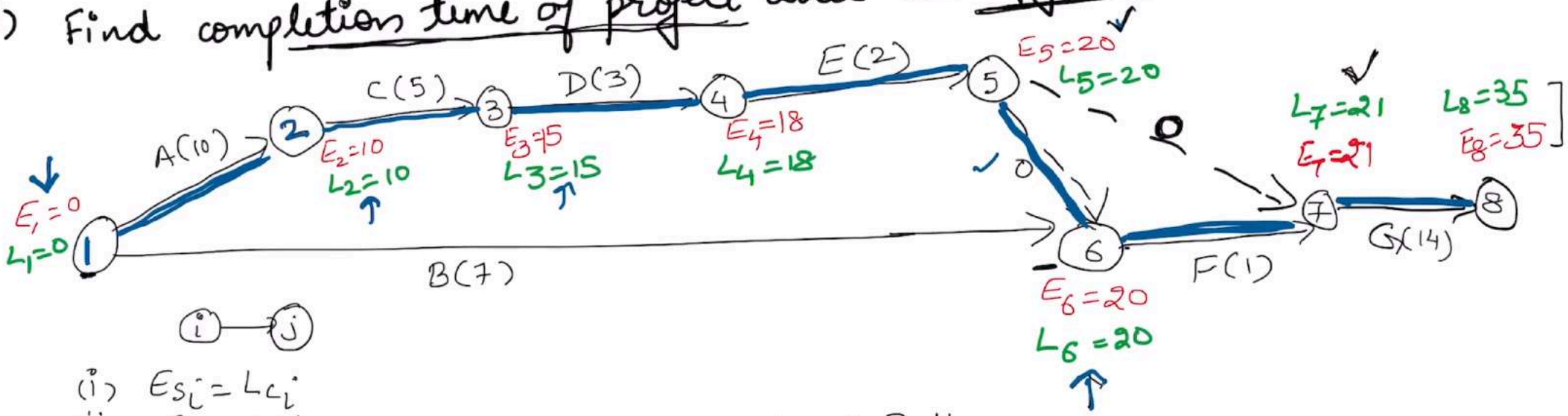
Critical Path: A path which comprises only critical activities & spans entire network is called critical path.

(Longest duration / minimum time duratio

Activity	: A	B	C	D	E	F	G
Preceding activities	: —	—	A	C	D	B, E	E, F
Time (Duration) (in days)	: 10	7	5	3	2	1	14

(i) Construct the network.

(ii) Find completion time of project and identify critical Path.



(i) $Es_i = Lc_i$

(ii) $Es_j = Lc_j$

(iii) $Es_j - Es_i = Lc_j - Lc_i = t_{ij}$

Critical Path.

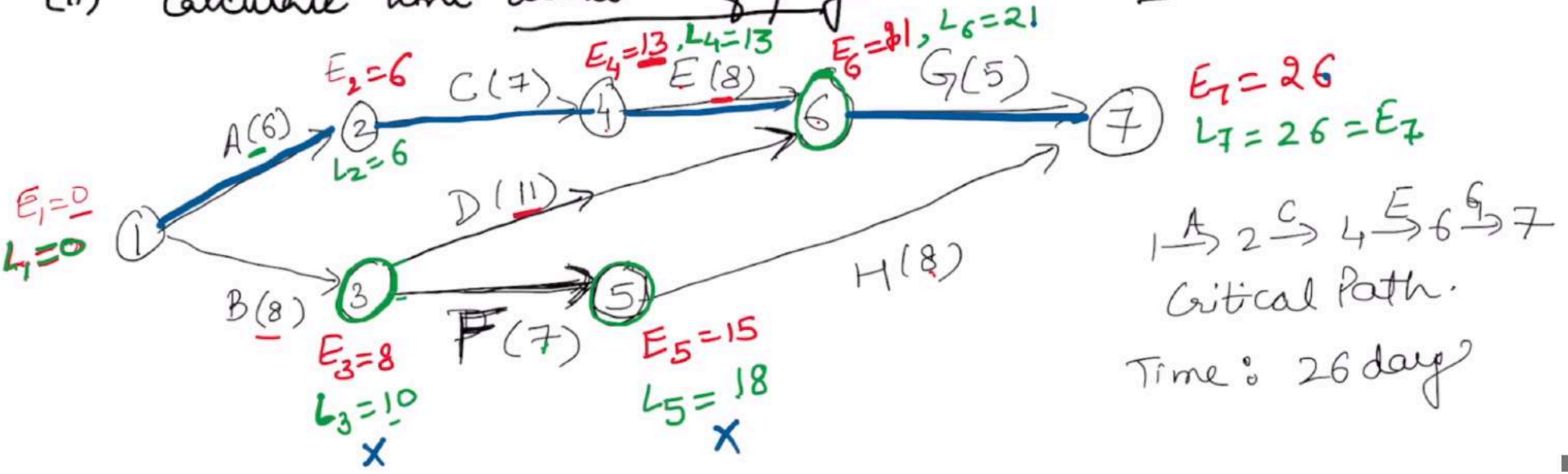
$1 \xrightarrow[A]{} 2 \xrightarrow[C]{} 3 \xrightarrow[D]{} 4 \xrightarrow[E]{} 5 \xrightarrow[\text{Dummy}]{} 6 \xrightarrow[F]{} 7 \xrightarrow[G]{} 8$

Example 4: consider the project;

Activity	A	B	C	D	E	F	G	H
Preceding activities	—	—	A	B	C	B	D, E	F
Time (Duration) (in days)	6	8	7	11	8	7	5	8

(i) Construct the network.

(ii) Calculate time duration of project and identify Critical Path.

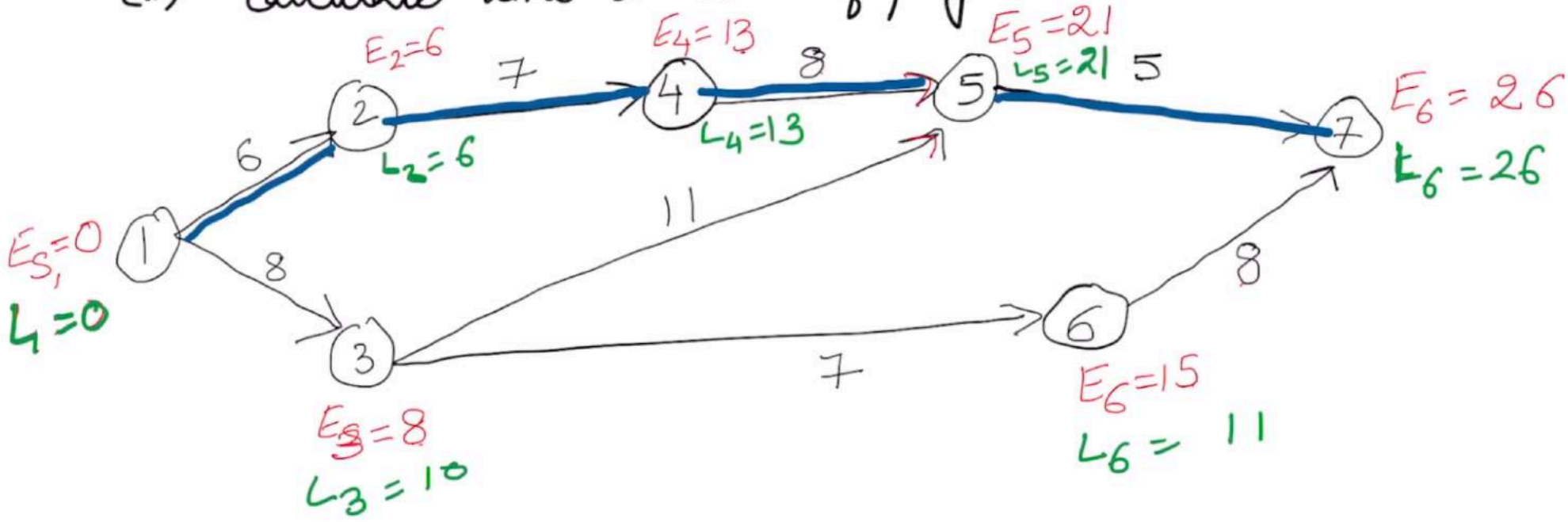


Example 5: consider the project;

Activity	1-2	1-3	2-4	4-5	3-5	3-6	5-7	6-7
Time (in days)	6	8	7	8	11	7	5	8

(i) Construct the network.

(ii) Calculate time duration of project and identify Critical Path.



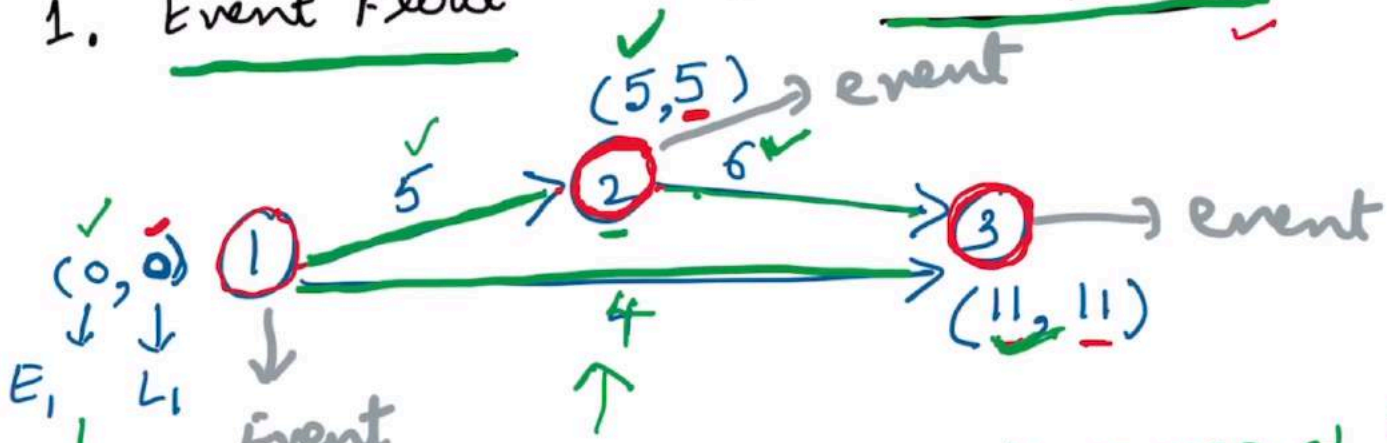
Float (or slack) of an Activity and Event

Thursday, 30 April 2020 7:00 AM

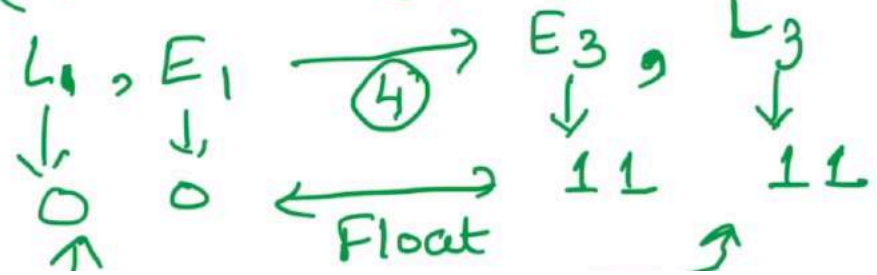
The Float is the free or delay or a gap of time occurence in a project for activity / event.

1. Event float

2. Activity float.



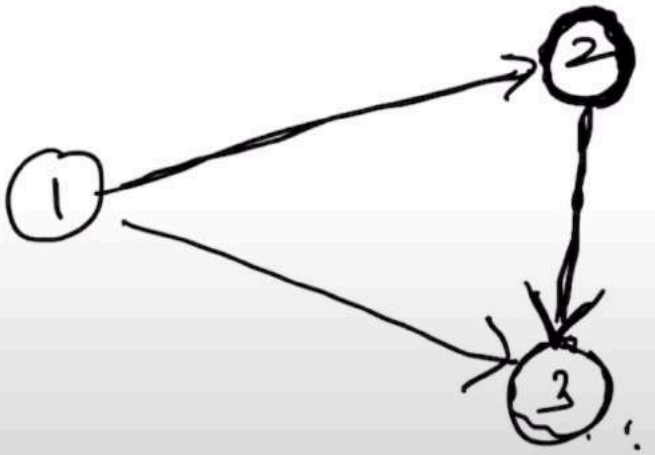
Activity 1-3 → (there is a gap of time



Event float: The float (or slack) of an event is the difference between its latest time (L_i) and its earliest time (E_i).

$$\text{Event float} = L_i - E_i$$

Eg:



$E_2 = 8$ ✓
$L_2 = 10$

$L_2 - E_2 = 2$ ✓

$L_i \geq E_i$

Event float > 0

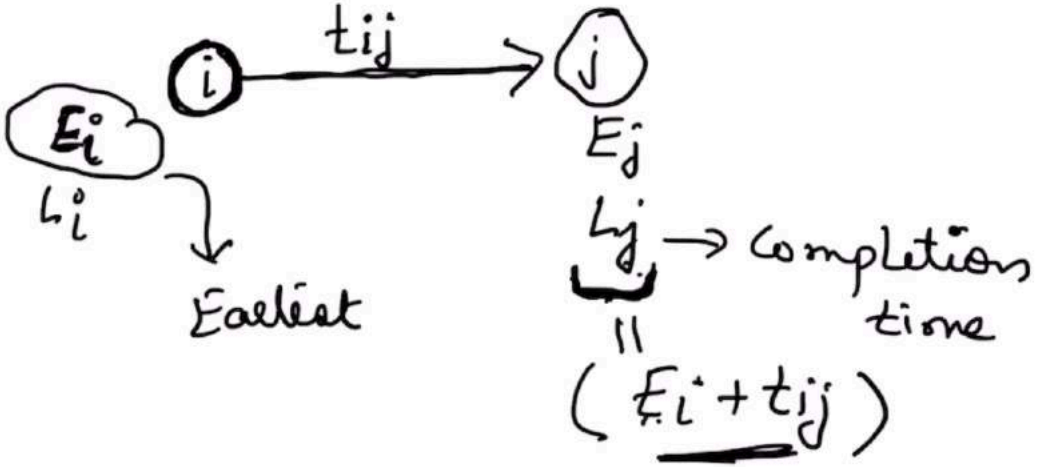
Activity float :

(i) Total float :

(Activity)

$$TF = L_j - (E_i + t_{ij}) \geq 0$$

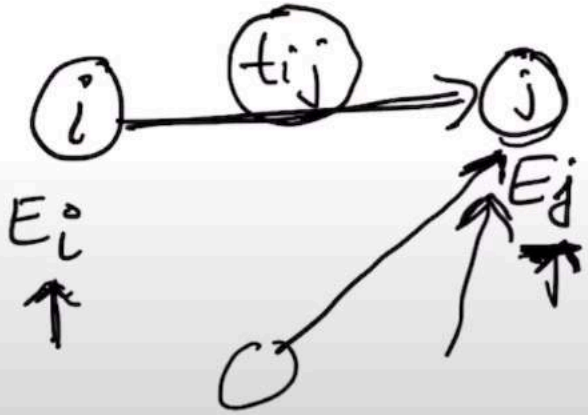
L_j → Latest, E_i → Earliest, t_{ij} → time



(If $L_j = E_i + t_{ij}$ then there is no float or no gap)

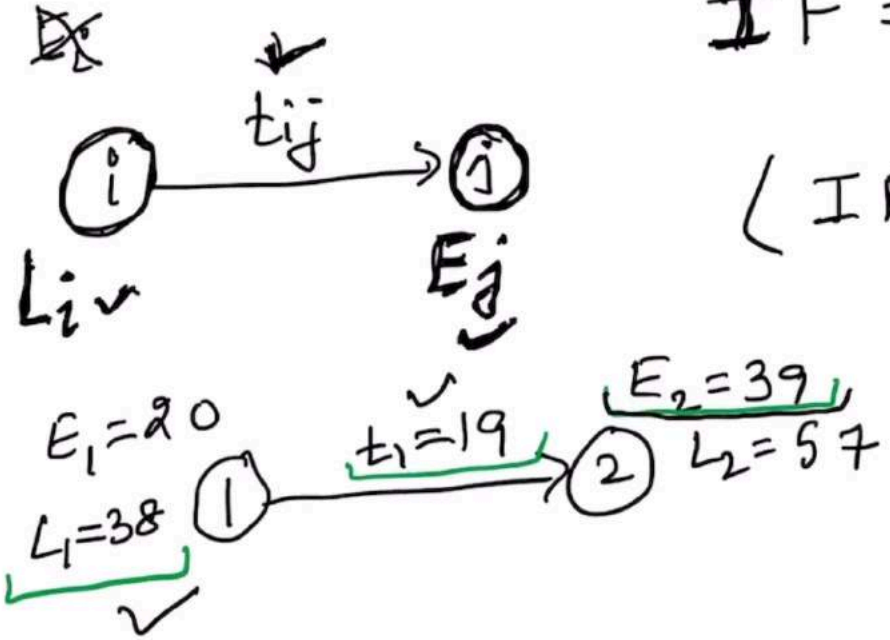
(ii) **Free Float:** (For an activity); this is free float time; by which an activity can be delayed without delaying in its immediate successor activities.

$$FF = E_j - (E_i + t_{ij}) \geq 0$$



(iii) **Independent Float.** It is that portion of the total float within which an activity can be delayed for its start without affecting floats of the preceding activities.

$$IF = (E_j - L_i) - t_{ij}$$



(IF may be -ve)

$$IF = (E_2 - L_1) - t_1$$
$$= E_2 - (L_1 + t_1)$$
$$= 39 - (38 + 19) = -18 < 0$$

Remarks:

(i) $L_i \geq E_i$; $\Rightarrow$ Independent Float $\leq$ Free Float $\leq$ Total Float

Independent Float → preceding

Free Float → successor

Total Float → all activities not delay in project

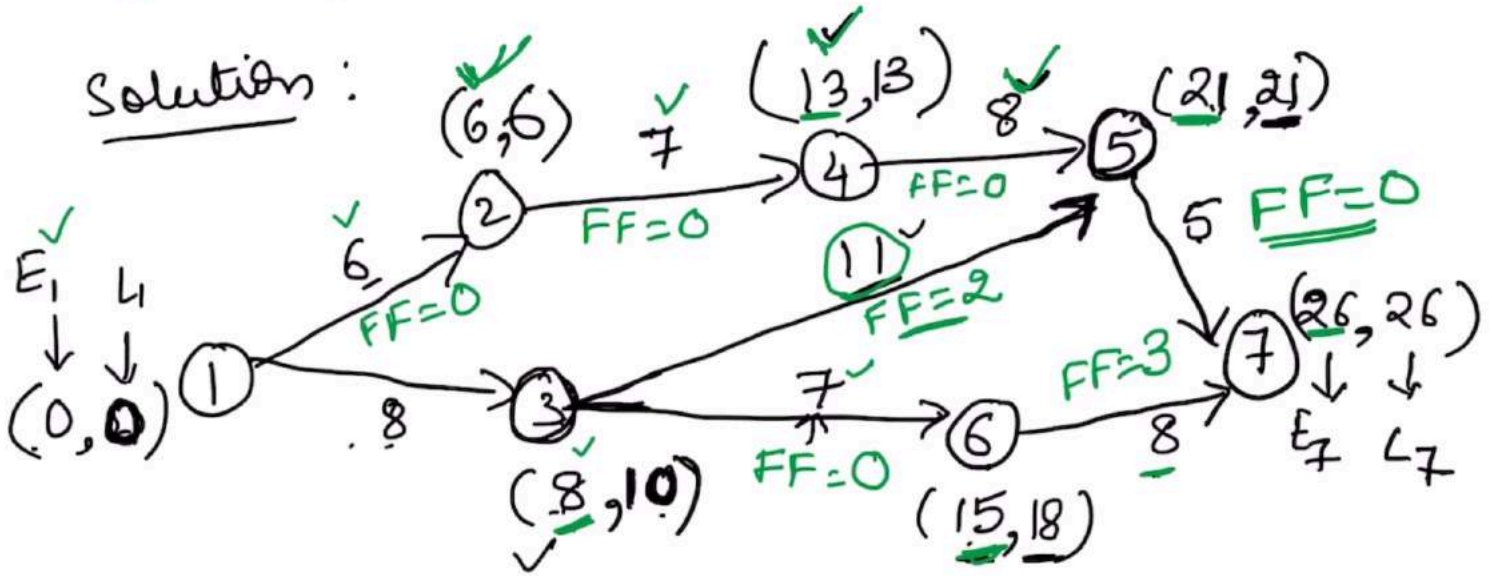
(ii) An activity is critical if its total float is zero. (TF = 0)

FF = 0 $\not\Rightarrow$ it is a critical activity.

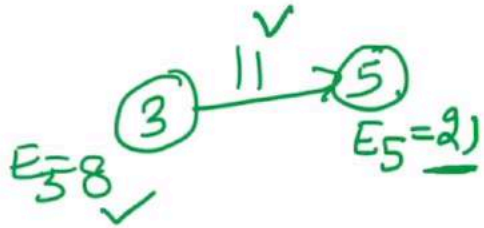
Example: Calculate free float of activities in given network.

Activities	Normal Time (T_N)
1-2	6
1-3	8
2-4	7
4-5	8
3-5	11
3-6	7
5-7	5
6-7	8

Solution:



$$FF = E_j - (E_i + t_{ij})$$



The end