Bahria University-Karachi Campus

Software Project Management

Fall-2024

Week 04

Engr. Majid Kaleem

مدرس: مہندس ماجد کلیم

جامعہ بحریہ، واقعگاہ کراچی

WEEK 04 - AGENDA

- How to Plan a Project
- Critical Path in Project Management
- Free slack and Total slack
- Schedule compression techniques
- Using the Lag Variable

SPM-FALL-2024

PROJECT NETWORK DIAGRAMS

- The Precedence Diagramming Method (PDM) and Critical Path Method (CPM) are both project management techniques used to plan, schedule, and manage tasks in a project. Here are brief definitions of each:

1. Precedence Diagramming Method (PDM): PDM is a graphical method used in project management to represent and analyze the *relationships* between various project tasks.

- It uses *nodes* to represent *tasks* and *arrows* to depict the *dependencies* or sequences between these tasks.
- PDM allows for the identification of task dependencies, including *finish-to-start, start-to-start, finish-to-finish, and start-to-finish* relationships.
- It is also known as *Activity On Node (AON)*.

SPM_FALL-2024

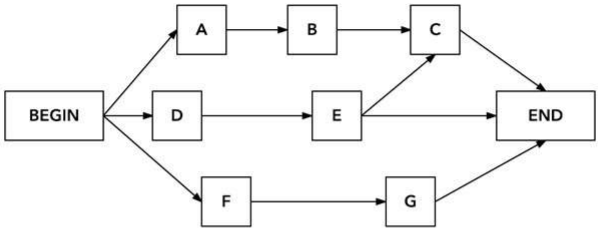
PROJECT NETWORK DIAGRAMS

2. Critical Path Method (CPM): CPM is a project management technique that utilizes a network of tasks and their dependencies to determine the longest path of tasks, known as the critical path.

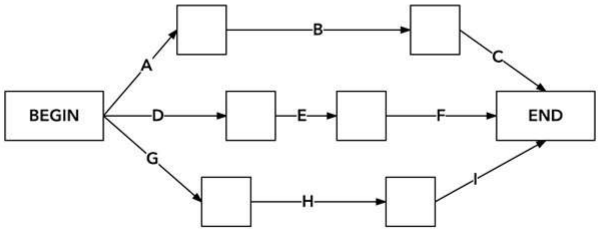
- The critical path represents the *shortest* time in which a project can be completed, as any delay in tasks on the critical path will directly impact the project's overall timeline.
- CPM helps project managers identify tasks that are *crucial* to completing the project on time and those that can be delayed without affecting the project's duration.
- It is also known as *Activity On Arrow (AOA)*.

SPM_FALL-2024

PROJECT NETWORK DIAGRAMS

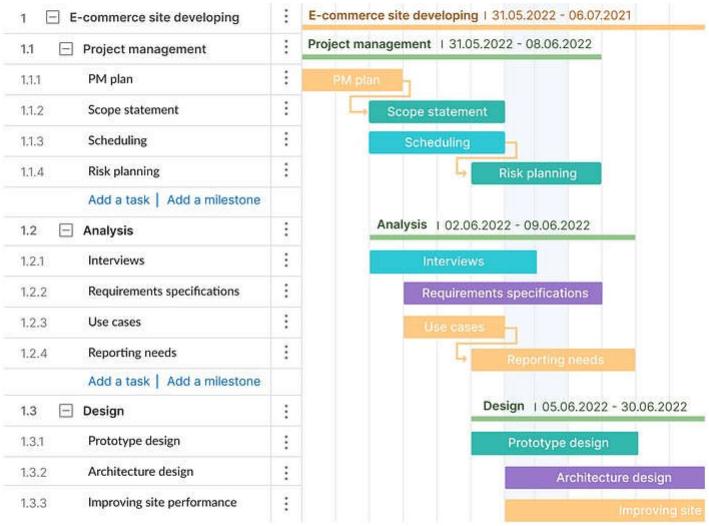


Activity on Node

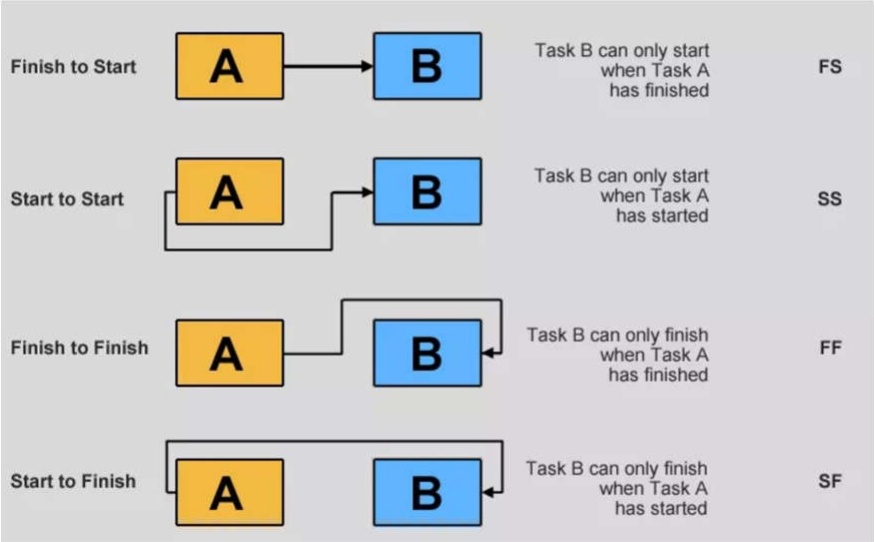


Activity on Arrow

WBS & GANTT CHART



TASKS RELATIONSHIPS



TASKS RELATIONSHIPS

- Start-to-Start (SS): In a Start-to-Start dependency, two tasks must start at the same time. They are linked, and both tasks start concurrently. For your payroll software project:
- Task 1: Requirement Gathering
- Task 2: Software Development
- In this case, Task 2 (Software Development) cannot start until Task 1 (Requirement Gathering) starts.

TASKS RELATIONSHIPS

- Start-to-Finish (SF): In a Start-to-Finish dependency, one task must start before another task can finish. For your payroll software project:
- Task 1: Data Input
- Task 2: Data Validation
- Task 2 (Data Validation) cannot finish until Task 1 (Data Input) starts. This could mean that as soon as data input begins, validation starts and continues alongside data entry until it finishes.

SPM-FALL-2024

TASKS RELATIONSHIPS

- Finish-to-Finish (FF): In a Finish-to-Finish dependency, one task must finish before another task can finish. For your payroll software project:
- Task 1: Quality Assurance Testing
- Task 2: Documentation
- Task 2 (Documentation) cannot be finished until Task 1 (Quality Assurance Testing) finishes. This ensures that documentation is updated based on the results of the testing phase.

SPM-FALL-2024

PRECEDENCE DIAGRAM METHOD (PDM/AON)

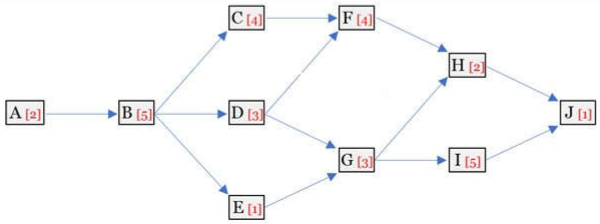
- Finish-to-Start (FS): In a Finish-to-Start dependency, one task must finish before another task can start. For your payroll software project:
- Task 1: Software Development
- Task 2: User Acceptance Testing
- Task 2 (User Acceptance Testing) cannot start until Task 1 (Software Development) finishes. Once development is complete, testing can begin.

PRECEDENCE DIAGRAM METHOD (PDM/AON)

Activity	Description	Estimated Duration (Days)	Predecessor
A	Submit FYP Proposal	2	None
B	Collect User Requirements	5	A
C	Prepare App. Design & Architecture (UML Diagrams)	4	B
D	Design Database Models (ERDs)	3	B
E	Design User Interfaces (High/Low Fidelity Models)	1	B
F	Develop Database (Back-end)	4	C, D
G	Develop Software Application (Coding)	3	D, E
H	Develop User Interfaces (Front-end)	2	F, G
I	Perform QA & Testing	5	G
J	Deploy & Demonstrate	1	H, I

PRECEDENCE DIAGRAM METHOD (PDM/AON)

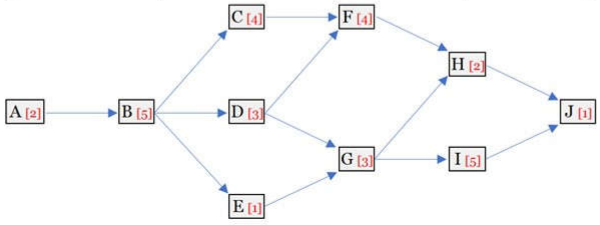
Activity	Description	Estimated Duration (Days)	Predecessor
A	Submit FYP Proposal	2	None
B	Collect User Requirements	5	A
C	Prepare App. Design & Architecture (UML Diagrams)	4	B
D	Design Database Models (ERDs)	3	B
E	Design User Interfaces (High/Low Fidelity Models)	1	B
F	Develop Database (Back-end)	4	C, D
G	Develop Software Application (Coding)	3	D, E
H	Develop User Interfaces (Front-end)	2	F, G
I	Perform QA & Testing	5	G
J	Deploy & Demonstrate	1	H, I



SPM-FALL-2024

PRECEDENCE DIAGRAM METHOD (PDM/AON)

Possible paths	Path	Total
Path 1	A + B + C + F + H + J	18
	2 + 5 + 4 + 4 + 2 + 1	
Path 2	A + B + D + F + H + J	17
	2 + 5 + 3 + 4 + 2 + 1	
Path 3	A + B + D + G + H + J	16
	2 + 5 + 3 + 3 + 2 + 1	
Path 4	A + B + D + G + I + J	19
	2 + 5 + 3 + 3 + 5 + 1	
Path 5	A + B + E + G + I + J	17
	2 + 5 + 1 + 3 + 5 + 1	



SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)

- Critical Path Method (CPM) is a method used in project planning, generally for project scheduling for the on-time completion of the project.
- It actually helps in the determination of the *earliest time* by which the whole project can be completed.
- There are two main concepts in this method namely critical task and critical path:

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)

a. Critical task is a task/activity that can't be delayed otherwise the completion of the whole project will be delayed. It must be completed on time before starting the other dependent tasks.

b. Critical path is a sequence of critical tasks/activities and is the *largest/longest* path in the project network. It gives us the minimum time which is required to complete the whole project. The activities in the critical path are known as *critical activities* and *if these activities are delayed then the completion of the whole project is also delayed*.

SPM-FALL-2024

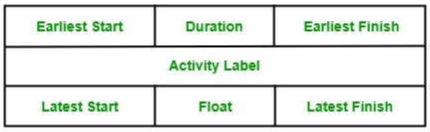
CRITICAL PATH METHOD (CPM/AOA)

Activity	Duration (in Weeks)	Predecessor
A	6	-
B	4	-
C	3	A
D	4	B
E	3	B
F	10	-
G	3	E, F
H	2	C, D

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)

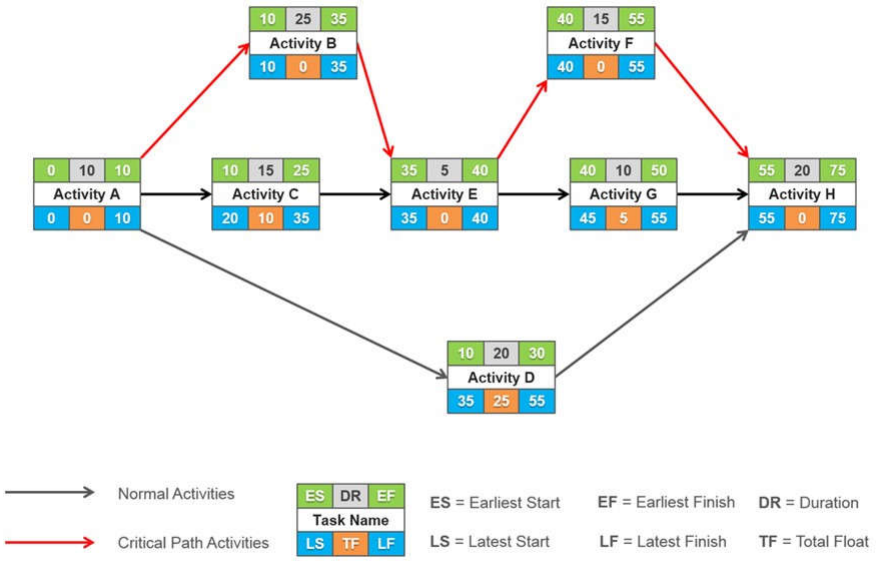
- Activity label is the name of the activity represented by that node.
- Earliest Start is the date or time at which the activity can be started at the earliest.
- Earliest Finish is the date or time at which the activity can completed at the earliest.



- Latest Start is the date or time at which the activity can be started at the latest.
- Latest Finish is the date or time at which the activity can be finished at the latest.
- Float is equal to the difference between earliest start and latest start or earliest finish and latest finish.

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)



CRITICAL PATH METHOD (CPM/AOA)

1. Early Start (ES): Early Start is the earliest point in time when a particular task can begin, based on its dependencies and the project schedule. It is calculated as follows:
   - ES = Maximum of (ES of preceding tasks) + Duration of the task
2. Early Finish (EF): Early Finish is the earliest point in time when a particular task can be completed. It is calculated as follows:
   - EF = ES + Duration of the task
3. Late Start (LS): Late Start is the latest point in time a task can start without delaying the project's completion. It is calculated as follows:
   - LS = LF - Duration of the task

CRITICAL PATH METHOD (CPM/AOA)

4. Late Finish (LF): Late Finish is the latest point in time a task can be completed without delaying the project's completion. It is calculated as follows:
   - LF = Minimum of (LF of succeeding tasks) or (Project Completion Time)

5. Float (Total Float or Slack): Float represents the amount of time a task can be delayed without impacting the project's completion date. It is calculated as follows:
   - Float = LS - ES or Float = LF - EF (They should yield the same result)

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)

1. Early Start (ES) represents the earliest start of an activity considering the dependency preceding task.

- If an activity has more than one dependency predecessor, then ES will be the highest Early Finish (EF) of the dependency task.
- Early Start = Maximum (or Highest) EF value from immediate Predecessor(s)

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)

2. In order to calculate Early Finish, we use forward pass. Means moving from Early Start towards right to come up with Early Finish of the project.

- Early Finish (EF) = ES + Duration
- If Early Start is 6 days and duration is 10 days, EF = 6 + 10 = 16 Days

SPM-FALL-2024

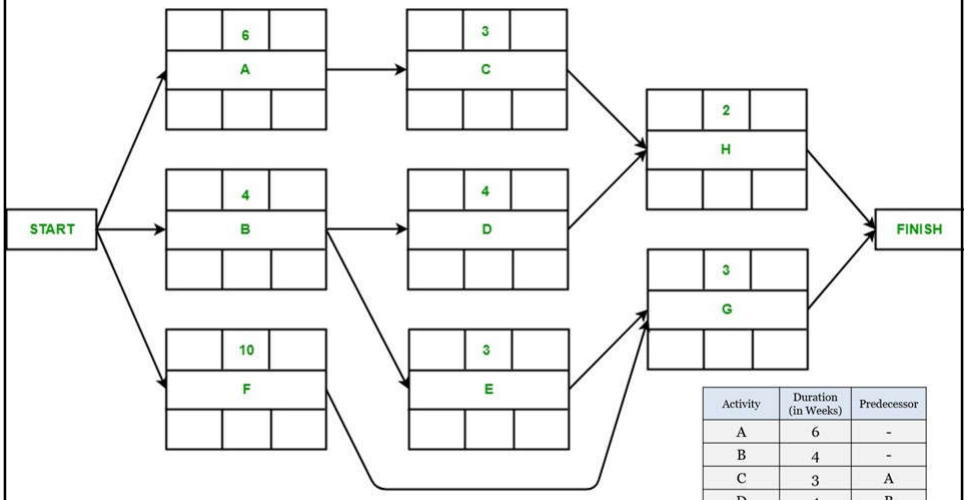
CRITICAL PATH METHOD (CPM/AOA)

3. Late Start (LS) is the latest date that the activity can finish without causing a delay to the project completion date.

- In order to calculate Late Start (LS), we apply backward Pass moving from Late Finish and deducting from activity duration.
- LS = LF – Duration
- If Late Finish is 30 days and duration is 10 days, LS = 30 – 10 = 20 Days

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)



Activity	Duration (in Weeks)	Predecessor
A	6	-
B	4	-
C	3	A
D	4	B
E	3	B
F	10	-
G	3	E, F
H	2	C, D

CRITICAL PATH METHOD (CPM/AOA)

- The *forward pass* is carried out to calculate the earliest dates on which each activity may be started and completed.

1. Activity A may start immediately. Hence, earliest date for its start is zero i.e. ES(A) = 0. It takes 6 weeks to complete its execution. Hence, earliest it can finish is week 6 i.e. EF(A) = 6.

2. Activity B may start immediately. Hence, earliest date for its start is zero i.e. ES(B) = 0. It takes 4 weeks to complete its execution. Hence, earliest it can finish is week 4 i.e. EF(B) = 4.

3. Activity F may start immediately. Hence, earliest date for its start is zero i.e. ES(F) = 0. It takes 10 weeks to complete its execution. Hence, earliest it can finish is week 10 i.e. EF(F) = 10.

CRITICAL PATH METHOD (CPM/AOA)

4. Activity C starts as soon as activity A completes its execution. Hence, earliest week it can start its execution is week 6 i.e. ES(C) = 6. It takes 3 weeks to complete its execution. Hence, earliest it can finish is week 9 i.e. EF(C) = 9.

5. Activity D starts as soon as activity B completes its execution. Hence, earliest week it can start its execution is week 4 i.e. ES(D) = 4. It takes 4 weeks to complete its execution. Hence, earliest it can finish is week 8 i.e. EF(D) = 8.

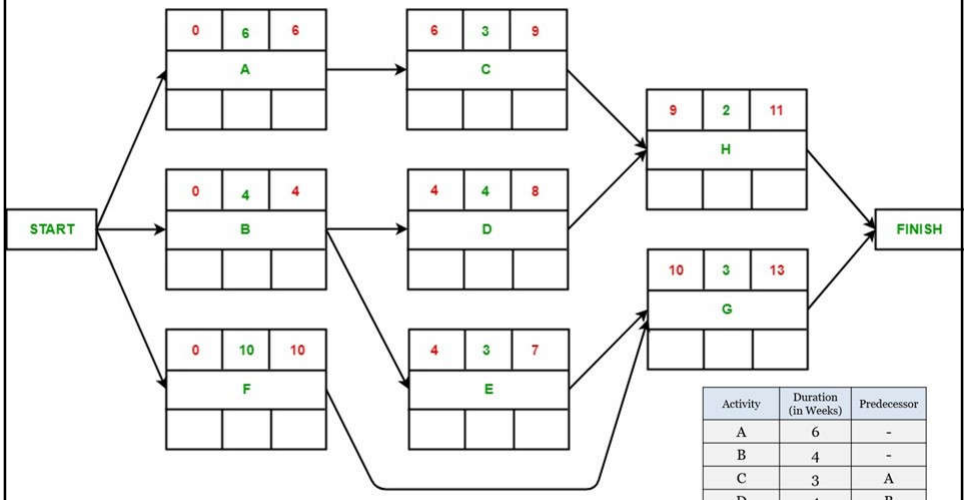
6. Activity E starts as soon as activity B completes its execution. Hence, earliest week it can start its execution is week 4 i.e. ES(E) = 4. It takes 3 weeks to complete its execution. Hence, earliest it can finish is week 7 i.e. EF(E) = 7.

CRITICAL PATH METHOD (CPM/AOA)

7. Activity G starts as soon as activity E and activity F complete their execution. Since activity requires the completion of both for starting its execution, we would consider the MAX(ES(E), ES(F)). Hence, the earliest week it can start its execution is week 10 i.e. ES(G) = 10. It takes 3 weeks to complete its execution. Hence, the earliest it can finish is week 13 i.e. EF(G) = 13.

8. Activity H starts as soon as activity C and activity D completes their execution. Since, activity requires the completion of both for starting its execution, we would consider the MAX(ES(C), ES(D)). Hence, the earliest week it can start its execution is week 9 i.e. ES(H) = 9. It takes 2 weeks to complete its execution. Hence, the earliest it can finish is week 11 i.e. EF(H) = 11.

CRITICAL PATH METHOD (CPM/AOA)



Activity	Duration (in Weeks)	Predecessor
A	6	-
B	4	-
C	3	A
D	4	B
E	3	B
F	10	-
G	3	E, F
H	2	C, D

CRITICAL PATH METHOD (CPM/AOA)

- The *backward pass* is carried out to calculate the latest dates on which each activity may be started and finished without delaying the end date of the project.
- *Assumption:* Latest finish date = Earliest Finish date (of project).

1. Activity G's latest finish date is equal to the earliest finish date of the precedent activity of finish according to the assumption i.e. LF(G) = 13. It takes 3 weeks to complete its execution. Hence, the latest it can start is week 10 i.e. LS(G) = 10.

2. Activity H's latest finish date is equal to the earliest finish date of the precedent activity of finish according to the assumption i.e. LF(H) = 13. It takes 2 weeks to complete its execution. Hence, the latest it can start is week 11 i.e. LS(H) = 11.

CRITICAL PATH METHOD (CPM/AOA)

3. The latest end date for activity C would be the latest start date of H i.e. LF(C) = 11. It takes 3 weeks to complete its execution. Hence, the latest it can start is week 8 i.e. LS(C)= 8.

4. The latest end date for activity D would be the latest start date of H i.e. LF(D) = 11. It takes 4 weeks to complete its execution. Hence, the latest it can start is week 7 i.e. LS(D) = 7.

5. The latest end date for activity E would be the latest start date of G i.e. LF(G) = 10. It takes 3 weeks to complete its execution. Hence, the latest it can start is week 7 i.e. LS(E) = 7.

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)

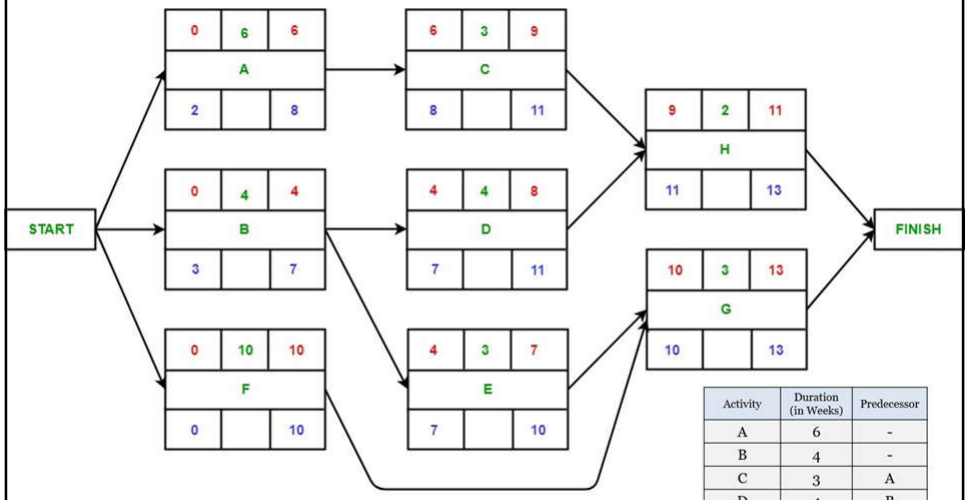
6. The latest end date for activity F would be the latest start date of G i.e. LF(G) = 10. It takes 10 weeks to complete its execution. Hence, latest it can start is week 0 i.e. LS(F) = 0.

7. The latest end date for activity A would be the latest start date of C i.e. LF(A) = 8. It takes 6 weeks to complete its execution. Hence, latest it can start is week 2 i.e. LS(A) = 2.

8. The latest end date for activity B would be the earliest of the latest start date of D and E i.e. LF(B) = 7. It takes 4 weeks to complete its execution. Hence, latest it can start is week 3 i.e. LS(B) = 3.

SPM-FALL-2024

CRITICAL PATH METHOD (CPM/AOA)



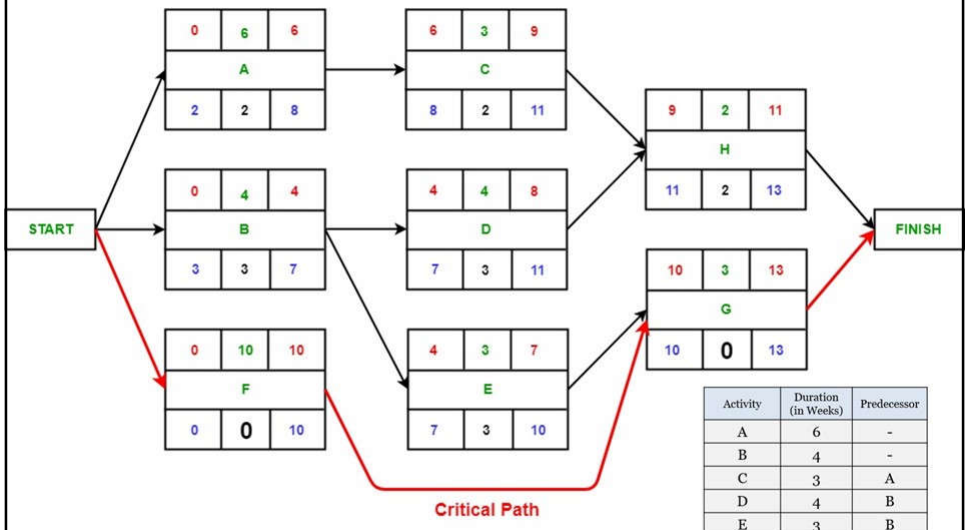
Activity	Duration (in Weeks)	Predecessor
A	6	-
B	4	-
C	3	A
D	4	B
E	3	B
F	10	-
G	3	E, F
H	2	C, D

IDENTIFYING CRITICAL PATH:

- Critical path is the path which gives us or helps us to estimate the earliest time in which the whole project can be completed. Any delay to an activity on this critical path will lead to a delay in the completion of the whole project. In order to identify the critical path, we need to calculate the activity float for each activity.

- Activity float is actually the difference between an activity's Earliest start and its latest start date or the difference between the activity's Earliest finish and its latest finish date and it indicates that how much the activity can be delayed without delaying the completion of the whole project. *If the float of an activity is zero, then the activity is an critical activity and must be added to the critical path of the project network.* In this example, activity F and G have zero float and hence, are critical activities.

IDENTIFYING CRITICAL PATH:



Activity	Duration (in Weeks)	Predecessor
A	6	-
B	4	-
C	3	A
D	4	B
E	3	B
F	10	-
G	3	E, F
H	2	C, D

FREE FLOAT & SLACK TIME

- Free Float (FF):
  - Free Float is the amount of time that a task within a project can be delayed without delaying the *early start* of its dependent tasks.
  - It is essentially the time a task can be postponed without affecting the overall project schedule.
  - Free float is associated with *non-critical* path tasks.
  - It allows project managers to identify tasks that can be delayed without impacting project completion.
  - FF = Minimum $ES_{successors} - ES_{activity} - Duration_{activity}$
  - FF ≤ TF

FREE FLOAT & SLACK TIME

- Total Float, or *"slack time"*, represents the total amount of time a task can be delayed without delaying the project's final completion date.
- Total float can help project managers prioritize tasks and allocate resources effectively.
- TF = LF – EF → Finish Float
- TF = LS – ES → Start Float

SPM-FALL-2024

FREE FLOAT & SLACK TIME

- Slack Time:
  - Slack time is another term for Total Float. It is the amount of time by which a non-critical task's start or finish date can be delayed without impacting the project's completion date.
  - Slack time is particularly important for project scheduling and resource allocation, as it allows project teams to identify where schedule flexibility exists.

SPM-FALL-2024


To be continued...
SPM-FALL-2024
13-Oct-2024
Engr. Majid Kaleem
39