PYQ (Dec) What is critical path?

ans ⇒ The critical path is the longest sequence of dependent tasks in a project that determines the shortest possible duration to complete the project. if any task on the path is delayed, the entire project timeline is affected.

Example: Consider a project with the following tasks and durations:

Task	Duration (days)	Predecessors
A	3	—
B	4	A
C	2	A
D	5	B, C
E	3	D

critical path calculation:

- Path 1: A → B → D → E = 3+4+5+3 = 15 days
- Path 2: A → C → D → E = 3+2+5+3 = 13 days

Since path 1 takes 15 days, it is the critical path.

PYQ Difference between PERT and CPM network. explain the circumstances under which one is prefered over other?

Features	PERT	CPM
stands for	PERT stands for project Evaluation and Review Technique.	CPM stands for critical path Method.
Definition	PERT is a technique of project management which is used to manage uncertain (time is not known) activities of any project.	CPM is a technique of project management which is used to manage only certain (time is known) activities of any project.
orientation	It is event oriented technique which means that network is constructed on the basis of event.	It is activity oriented technique which means that network is constructed on the basis of activities.

Model Type	It is a probability model	It is a deterministic model.
Focus	It majorly foucses on time.	It majorly foucses on Time - cost trade off.
precision	It is appropriate for high precision time estimation	It is appropriate for reasonable time estimation
Nature of job	It has Non-repetitive nature of job.	It has repetitive nature of job.
crashing	There is no chance of crashing as there is no certainty of time.	There may be crashing because of certain time bound.
dummy Activities	It doesn't use any dummy activities.	It uses dummy activities.

Circumstance for choosing PERT or CPM

(i) situation: Research & development
prefered: PERT,
Reason: High uncertainty in task durations.

(ii) situation: construction and Infrastructure
prefered: CPM
Reason: Fixed timelines and predictable task duration.

conclusion: Use PERT when dealing with uncertainty in project timelines such as (Research and Dev-), Software Development.
Use CPM when dealing with predictable and well-defined activities such as Construction, maintenance.

Pg 09 what is work breakdown structure, explain with the help of an example.

ans ⇒ A work Breakdown structure includes dividing a large and complex project into simpler manageable and independent tasks. It helps in organizing and defining the total scope of the project by breaking it down into deliverables and work packages.

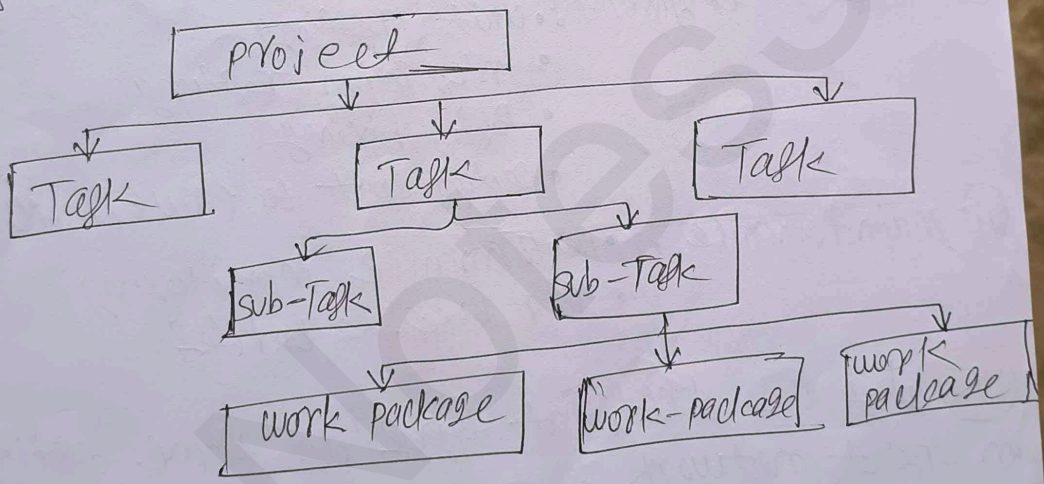
Steps work Breakdown structure

Step1: identify the major activities of the project.

Step 2: identify the sub activities of the major activities.

Step3: identify the work-package of the sub-activities.

Step4: Repeat till undividable, simple and independent activities are created.



Example of WBS.

project: Developing an E-commerce website

Level 1: E-commerce website Development

Level 2: (main phase) ① project planning ② Design & UI/UX ③ Backend Development ④ Frontend Development ⑤ Testing & Deployment ⑥ maintenance

level 3 : (Sub Task)

(i) project planning : • Requirement Gathering
• Feasibility study
• Resource Allocation

(ii) Design UI/UX : • wireframing
• UI/UX Design

(iii) Backend Development : • Database design
• Server-side logic
• API development

(iv) Frontend Development : • layout & component Design
• integrating APIs
• Responsive Design

(v) Testing & Deployment : • unit Testing
• integration Testing
• Bug fixing
• Deployment to (AWS, netlify).

(vi) Maintenance : • performance Monitoring
• Bug fixes & updates

PYQ what are different types of time estimates in pert network.

ans ⇒ Time estimates refers to the predicted duration required to complete a task, activity or project phase. These estimates help in project planning, scheduling, resource allocation, and monitoring progress.

PERT uses three different time estimates: ~~to account~~

(i) optimistic Time (ii) Most likely Time (iii) Pessimistic Time

① Optimistic Time (O or to): The shortest possible time required to complete an activity under ideal conditions. Assumes everything goes smoothly without delays.

② Most Likely Time (M or tm): The best estimate of the time required to complete an activity based on ~~optimal~~ normal conditions. It is the most realistic duration considering potential minor issues.

③ Pessimistic Time (P or tp): The longest possible time an activity might take if there are significant delays or worst-case scenarios.

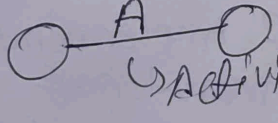
Expected Time (TE or te) calculation

$$te = \frac{to + 4tm + tp}{6}$$

PYQ Brief the terms 'Activity and 'Event', or diff b/w Activity and Event.

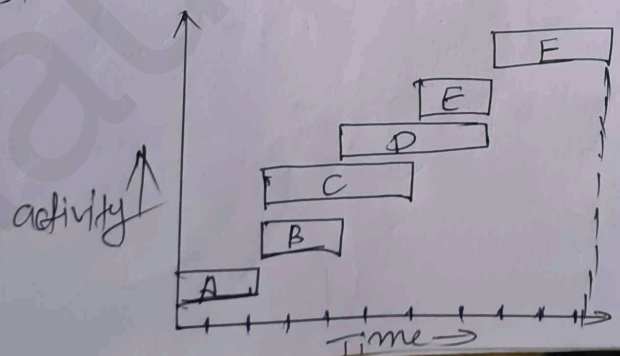
Activity: An Activity is a specific task or work package that needs to be completed as part of a project. Activities have defined start and end time, required resources and contribute to project deliverable.

Ex⇒ Developing a website homepage, testing a software module.



Feature	Forward pass	backward pass
Definition	Forward pass calculates the earliest start (ES) and earliest finish (EF) times for activities.	Backward pass calculates the latest start (LS) and latest finish (LF) times for activities.
purpose	Determines the earliest possible completion time of the project.	Determines the latest possible time activities can be completed without delaying the project.
Direction	Moves left to Right through the network diagram	Moves right to left through the network diagram
Formula	EF = ES + duration	LS = LF - Duration
Starting Point	Starts from the projects start node with an ES of 0.	Starts from the projects end node, using the latest project completion time.
Focus	Determines how early an activity can start and finish	Determines how late an activity can start and finish without delaying the project

* Bar chart / Gantt chart : A bar chart also known as Gantt chart, it is a visual tool used to plan schedule, and track project activities over time. It represents tasks as horizontal bars along a timeline, showing their start and end dates, duration and dependencies



ensuring alignment with objectives.

(iv) project Monitoring & control: Tracks project progress, ensure quality, and mitigates risks or deviations.

(v) project closure: Ensures that all deliverables are completed, documented, and reviewed before handling over the project.

Example: E-commerce website development

(i) scope: Build an e-commerce website with user authentication, product listings, and a payment gateway.

(ii) planning: Define UI design, backend development, ~~product listings, and a payment gateway.~~ integration and testing.

(iii) Execution: Developers create the website, integrate APIs, and perform user testing.

(iv) Monitoring and control: Regular team meetings track progress, resolve bugs, and adjust tasks as needed.

(v) closure: The website is tested, deployed and handed over to the client, with final documentation provided.

(Q9) What are the difference between forward and backward pass?

(ii) Event: An event is a significant milestone or occurrence within a project that marks a completion, transition or decision point, unlike activity, events do not consume time or resources. they signify the completion of one or more activities.

Example: Approval of a design phase, or product launch

Features	Activity	Event
Definition	A task or set of tasks in a project.	A milestone marking the completion of activity
Time Duration	Requires time to complete	No time duration required
Resource Requirement	Needs resources	Does not require resource.
Example	Designing a website	project approval
representation	represented as an arrow	represented as a node

PYQ Describe the components of project Management with a suitable example.

ans ⇒ project Management consists of several key components that ensures the succeggful planning, execution and completion of a project. These components include.

(i) project scope: Defines the objectives, deliverables and boundaries of the project.

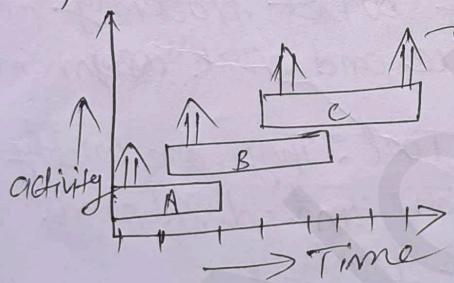
(ii) project planning: Involves defining tasks, timeline resources, and risk management strategies.

(iii) project Execution: Involves implementing the project plan by assigning tasks, monitoring progress, and

Advantages of Bar chart
(i) simple and Easy to understand
(ii) Effective Task scheduling
(iii) progress Tracking
(iv) Task Dependencies (v) Draw back of bar chart

Disadvantages of Bar chart
(i) Complexity in large projects.
(ii) Lack of flexibility.
(iii) Not suitable for ~~All~~ Agile projects.
(iv) ~~(v)~~ Limited in showing critical path.

Milestone chart: A milestone chart in project management is a visual representation of key events, milestone, deadlines, or achievements in a project. It helps track progress, set priorities, and ensure timly completion of critical tasks. It is an improvement of bar chart.



Advantage of milestone chart:
(1) clear project overview
(2) improved communication
(3) Better time management
(4) simplifies Reporting

Disadvantages of milestone chart:
(i) Lack of detailed information
(ii) Limited flexibility
(iii) Does Not show Task Effort

Complexity	Become complex for large projects.	simpler and easier to large project
progress Tracking	Shows percentage completion of tasks	only indicates whether a milestone is achieved or not.
Timeframe	Covers the entire project duration.	Highlights only important dates without showing all task details.
Software Tools used	Microsoft project, smartsheet	Microsoft project, EXCel, Jira

~~or planning is the starting point of all management functions. Discuss.~~

(PYQ) State why project planning is important.

ans ⇒ project planning is crucial in project management, because it provides a structured approach to achieving project goals efficiently. Here are some key reasons why project planning is important.

1. Defines clear objectives: It sets clear goals, deliverables, and timelines, ensuring everyone understands the project's purpose.

2. improve Resource management: It helps allocate resources (time, budget, work force) effectively to avoid shortages or wastage.

3. Minimizes Risks: It identifies potential risks early and creates mitigation strategies to reduce project failure.

4. Enhance Team coordination: Establishes roles and responsibilities, ensuring smooth collaboration among team members.

Solution: ~~Use software tool like Microsoft P~~
Use arrows or network diagrams (like PERT or CPM) alongside the bar chart to show task dependencies.

(iii) Static Nature: Bar charts do not easily adjust to changes in real-time.

Solution: Use dynamic project management tools that allow real-time updates and collaboration.

(iv) Limited Resource Management: Bar charts do not effectively show resource allocation and constraints.

Solution: Integrate bar charts with resource histograms or workload charts to track resource usage.

(v) Difficult to Track parallel Tasks: When multiple tasks run concurrently, the chart can become hard to read.

Solution: Use color coding or swimlane diagrams to differentiate overlapping tasks.

(Pg) what is a milestone chart? How does it different from a bar chart?

Feature	Bar chart	Milestone chart
Definition	A graphical representation of project tasks over time using horizontal bars.	A chart showing key project milestones and deadlines.
purpose	Used to display tasks schedule, durations, and dependencies.	Used to highlight major events, deadlines or completion points.
Representation	Tasks are represented as bars spanning start to end dates.	Milestones are represented as points or symbols on a timeline.
Time focus	Covers the entire duration of tasks.	Focuses only on specific important dates.

PYQ) List the main advantages of Bar chart that make them so popular.

ans ⇒ (i) clear visualization: Bar charts provide a straightforward way to represent data, making trends, comparisons, and variations easy to understand.

(ii) Time Management: Bar charts help track project timelines, milestones, and deadlines.

(iii) Identifying Trends and patterns: By visually displaying data over time, bar charts help managers ~~data over time, bar~~ spot trends, detect bottlenecks and take corrective actions.

(iv) Simple and Easy to Interpret: Due to its simplicity bar charts are easy to understand and easy to draw.

(v) Versatility: They can be used for a wide range of project metrics, such as budget tracking, task progress, team performance and risk assessment.

(vi) Effective communication Tool: They are widely used in project reports, presentations, and dashboards to communicate project status clearly.

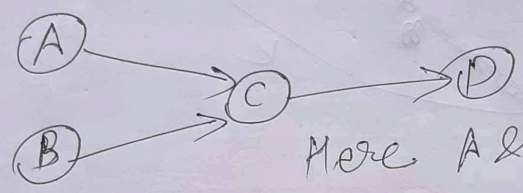
PYQ) what are the shortcoming/drawback/disadvantage of bar chart? how these can be removed.

ans ⇒ (i) Complexity in large projects: As projects grow, bar charts become difficult to understand.
Solution: Use software tool like Microsoft project to manage large scale charts with filtering options.

(ii) Lack of Dependency Representation: They do not clearly show dependencies between tasks.

Concurrent Activity: Concurrent activity refers to tasks or activities that occur simultaneously rather than sequentially. These activities overlap in time and can be executed in parallel to reduce project duration, increase efficiency, and optimize resources utilization.

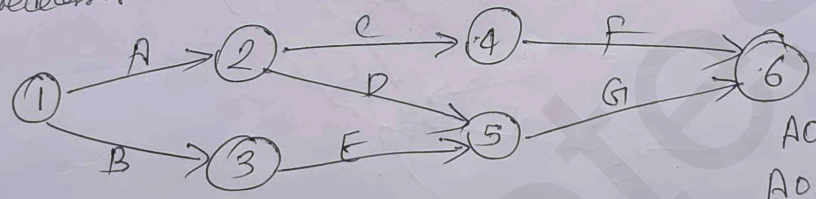
Ex:



Here A & B are the concurrent activity.

Construction of NW diagram

Activity:	A	B	C	D	E	F	G
~~Predecessor~~ Predecessor:	—	—	A	A	B	C	D, E

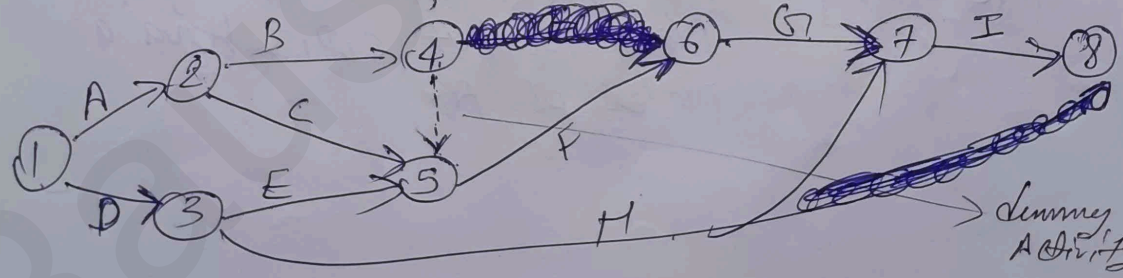


AOA: A

AON: (A)

Q.

Activity:	A	B	C	D	E	F	G	H	I
Predecessor:	—	A	A	—	D	B, C, E	F	D	G, H

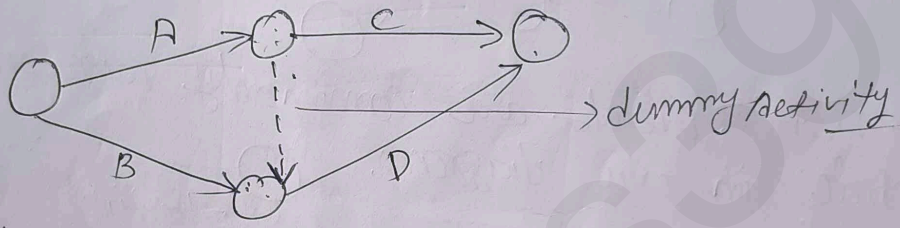


Dummy activity: An activity which does not consume either any resources is known as dummy activity.

Example: Draw a n/w diagram to express the following relationship.

Activity	immediate predecessor
A	—
B	—
C	A
D	A, B

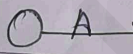
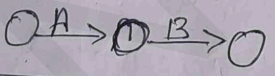
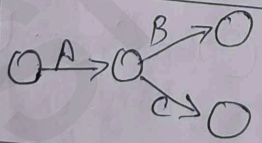
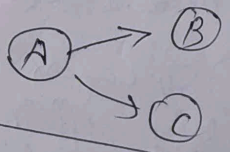
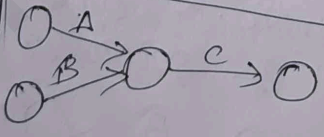
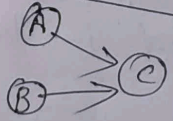
Soln:



Construction of N/W Diagram

(1) Activity on Node (AON) N/W.

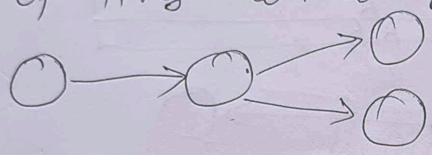
(2) Activity on Arrow (AOA) N/W.

		AOA N/W	AON N/W
1.	Activity A		
2.	B must follow A		
3.	B & C must follow A		
4.	C must follow A & B		

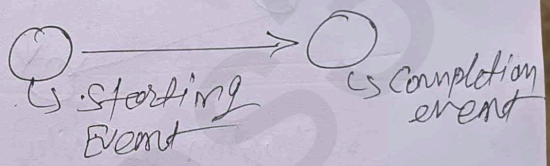
(5) Ensures Quality control: Outlines quality standards and checkpoints to maintain high project standards.

(6) Increases Efficiency and productivity: A well-structured plan helps teams work systematically, reducing delays and improving productivity.

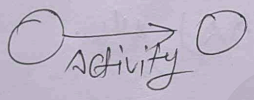
* Network: A network consist of a set of points and set of lines connecting different pairs of points.



* Events: Events are commonly represented by circles in n/w diagram.

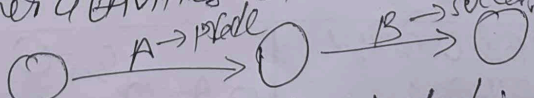


* Activity: The arrows are called activity.

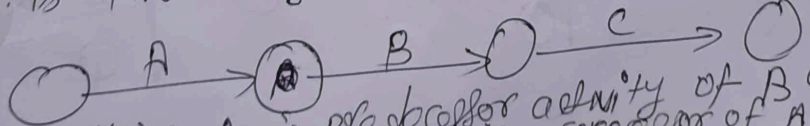


* Types of Activity

(1) predecessor activity: An activity must be completed before one or more other activities start is known as predecessor activity. Ex=>



(2) Successor activity: An activity which started immediately after one or more of other activity are completed is known as successor activity.

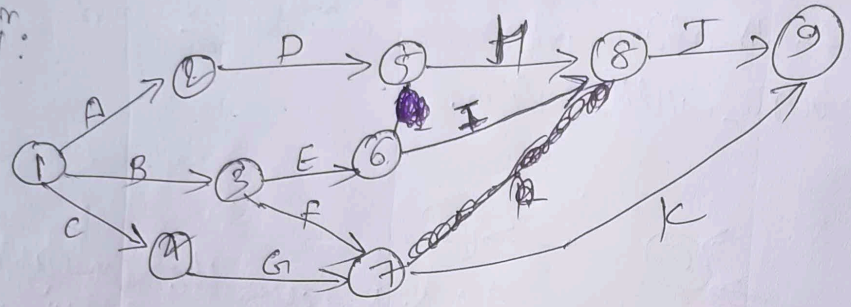


Here A is predecessor activity of B and B is successor of A.

①:

Activity:	A	B	C	D	E	F	G	H	I	J	K
predecessor:	—	—	—	A	B	B	C	D	E	H,I	F,G

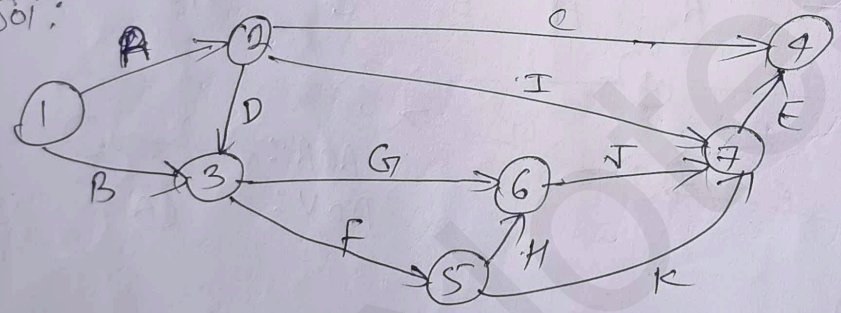
Soln:



②.

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

Soln:



Note: If you got 'A < C, D, I' then make activity first

A < C, D, I → means A does not have any predecessor but C, D, I have a predecessor A.

(pg0) Discuss the multiple time estimates used in pert network.

ans ⇒ already done

(pg0) Define slack

ans ⇒ slack also called float refers to the amount of time an activity can be delayed without affecting the project deadline or delaying dependent tasks. It helps project managers identify flexibility in scheduling and manage resources efficiently.

Types of slack

① Total slack ② Free slack

① Total slack (Total Float): The maximum time an activity can be delayed without delying the project completion date.

Formula ⇒ Total slack = Late start (LS) − Early start (ES)

or

Total slack = Late finish (LF) − Early finish (EF)

② Free slack (Free float): The time an activity can be delayed without delying the Early start of the next activity.

Formula

Freeslack = ES next − Ef current

Critical path: 1 → 2 → 3 → 5 → 8

Expected project duration (length): 7 + 14 + 11 + 4 = 36 weeks

(5) critical path → 1 → 2 → 3 → 5 → 8

$\sigma^2 + \sigma^2 + \sigma^2 + \sigma^2$

Project length variance $\Rightarrow \sigma^2 =$

$\sigma^2 = 4 + 16 + 4 + 1 = 25$

Project length standard deviation: $\sigma = 5$ $\left\{ \begin{array}{l} \sigma^2 = 25 \\ \sigma = 5 \end{array} \right.$

(6) Calculate the standard normal variable

$$D = \frac{Ts - Te}{\sigma}$$

where, Ts is the schedule time to complete the project

Te = Normal expected project length

σ = Expected standard deviations of the project length.

The probability that the project will be completed in 40 days is given by $P(Z \leq D)$

$$D = \frac{Ts - Te}{\sigma} \qquad D = \frac{40 - 36}{5} \qquad D = 0.8$$

$P(Z \leq 0.8) = 0.7881 \Rightarrow 78.81\%$

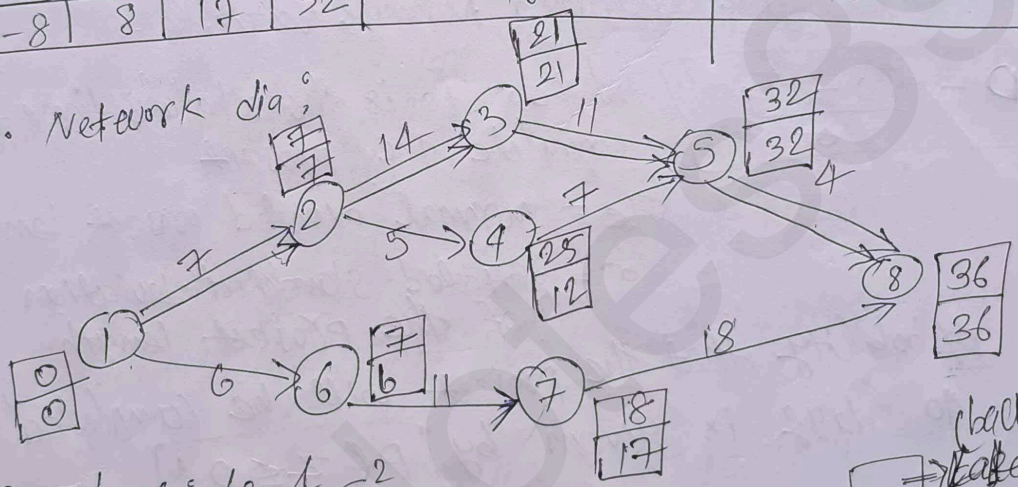
↑ See in normal dist table

ans

Soln :→ Critical path notation

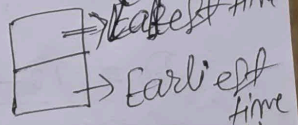
Activity	Estimated duration				(variance)^2
	t_o	t_m	t_p	$t_e = \frac{t_o + 4t_m + t_p}{6}$ expected time	$\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$
1-2	1	7	13	$\frac{1+4\times7+13}{6} = 7$	$\left(\frac{13-1}{6}\right)^2 = 4$
1-6	2	5	14	$=6$	4
2-3	2	14	26	14	16
2-4	2	5	8	5	1
3-5	7	10	19	11	4
4-5	5	5	17	7	4
6-7	5	8	29	11	16
5-8	3	3	9	4	1
7-8	8	17	32	18	16

Q1. Network dia;



Q2. done : t_e & σ^2

(3) Done in new dia



(4) Critical Activity: An activity is said to be critical if the total float for any activity is zero.

Critical path conditions.

(i) $ESi = LFi$

(ii) $ESj = LFj$

(iii) $ESj - Esi = Lfj - Lfi = tij$

④ The following table shows the Jobs of a n/w along with their time estimates.

Activity	Estimated duration (weeks)		
	optimistic to	most likely (tm	Pessimistic (tp)
1-2	1	7	13
1-6	2	5	14
2-3	2	14	26
2-4	2	5	8
3-5	7	10	19
4-5	5	5	17
6-7	5	8	29
5-8	3	3	9
7-8	8	17	32

you are required to

① Draw the project Network.

② Find the expected duration and variance of each activity.

③ Calculate the earliest and latest occurance for each event.

④ calculate expected project length.

⑤ calculate the variance and Standard deviations of project length.

⑥ find the probability of the project completing in 40 days.

Critical path 1 → 2 → 3 → 5 → 8

(PYQ) Give various types of Network planning technique.

Ans ⇒ There are main 2 type of NW planing tech.

① PERT ② CPM

① Program Evaluation and Review Technique:
PERT is a project management tool used for scheduling tasks with uncertain durations. It helps in estimating the probable time needed to complete each task. Pert used for projects where the exact time to complete tasks is not known. It uses three time estimates for each task.

(i) Optimistic time (O): The shortest possible time to complete the task.

(ii) Pessimistic time (P): The longest possible time to complete the task.

(iii) Most likely time (M): The most realistic time estimate

The expected time for each task is calculated using the formula $Ex\ Time = \frac{O + 4M + P}{6}$. It helps in identifying the critical path, which is the longest path that determines the shortest project duration.

② CPM (Critical path Method): CPM is a project management technique used for scheduling tasks with predictable durations. It helps in identifying the sequence of tasks that must be completed on time to prevent project delays.

(iii) Task Breakdown: Dividing the project into manageable tasks and activities.

(iv) Resource allocation: Assigning human, financial, and material resources.

(v) Scheduling: Creating timelines and milestone.

(vi) Risk assessment: Identifying potential risks and mitigation strategies.

(vii) Budgeting: Estimating costs and managing financial resources.

Advantages of project planning

(i) Clear direction: Ensures all stakeholders understand goals.

(ii) Efficient Resource utilization: It helps allocate resources effectively, minimizing waste.

(iii) Time management: A well-planned project follows a structured timeline, reducing delays.

(iv) Risk Reduction: Identifies potential risks easily and prepare strategies to handle them.

(v) Cost Control: prevents budget overruns by forecasting expenses in advance.

(vi) Quality assurance: Ensures project deliverables meet quality standards.

PYQ What are the objectives of project management

Key objectives

① Defining clear Goals and Scope: Ensuring the project has well-defined objectives, scope.

③ Independent float: The time an activity can delayed without affecting the early start of succeeding activities.

Independent float = Earliest start of next activity − Latest finish of current activity

④ Interfering float: The part of Total float that, if used, delays the early start of succeeding activities but does not delay project completion.

Interfering float = Total float − free float

⑤ Negative float: occures when the project is behind schedule, meaning the time available is less than the time required to complete an activity.

Negative float = Late start − Early start

(PYQ) what is meant by project planning? Discuss the need of planning a project.

project planning is the process of defining a project's scope, objectivies, tasks, schedule, resources, and deliverables before execution. It envolves a roadmap to ensure the project is completed efficiently within the given constraints (time, cost, scope). project planning includes

1. Defining objectivies: Clearly stating what need to be achieved.
2. Scope definition: Identifying project boundaries, deliverables, and exclusions.

It is used for projects where the time durations of tasks is known. It identifies the critical path, which is the longest sequence of dependent tasks in the project. It helps in optimizing resources by identifying float/slack. Tasks on the critical path cannot be delayed without delying the entire project

(Q9) Discuss the different types of floats and explain their significance?

Ans ⇒ Float refers to the amount of time an activity can delay without delaying the project completion time.

Types of floats

(i) Total float (ii) Free float (iii) Independent float (iv) Interfering float

(i) Total float: The maximum amount of time an activity can be delayed without delaying the overall project completion time. is called total float.

Significance: It helps to identify which task can be delayed without harming the final deadline.

Formula: TF = Latest start − Earliest start // TF = LS − ES

(2) Free float: The amount of time an activity can be delayed without delaying the earliest start of next activity.

Significance: It helps to manage dependencies b/w activities without affecting others.

Formula ⇒ FF = Ej − Ei − tij

(3) Independent float: The amount of time an activity can be delayed without delaying the previous or next tasks.

Significance: It shows the tasks with full flexibility.

Formula ⇒ IF = Ej − Li − tij

(4) Interfering float: The amount of time an activity can be delayed without affecting the project deadline but it may delay subsequent dependent tasks.

Significance: It shows how delays affect dependent activity but not the whole project.

IF = Total float − Free float

(b) Backward pass computation: for ending event.

assume $E = L$

$$(F_{ij}) = (f)_{ij} - t_{ij}$$

$$= L_j - t_{ij}$$

(c) total float: $(TE)_{ij} = (LS)_{ij} - (ES)_{ij}$

or

$$T_{Fij} = (L_j - E_i) - t_{ij}$$

Float: Diff b/w latest and earliest activity time

slack: Diff b/w latest and earliest event time.

Q. consider a project where activity are given below

Activity	1-2	1-3	2-4	3-4
Time	4	1	1	1

Discuss the following points

(i) draw the network diagram

(ii) calculate the ~~network time~~ earliest start, earliest finish, latest start, latest finish

(iii) Determine the critical path of project

(iv) calculate the Total float, free float, Independent float & interference float.

tracking progress.

④ Asana: A collaborative work management tool that helps teams plan, track, and manage tasks efficiently.

Time Analysis:

1. Forward Pass Computation
2. Backward pass computation
3. Determination of floats and slack time
4. Total Float
5. Free float

Note: Activity whose slack time is 0 is critical Activity, path having slack time is 0. is critical path.

6. Idependent float
7. Interference float
8. critical Activity
9. Critical path

T_{ij} → Estimate completion time of activity.

ES_{ij} ⇒ Earliest starting time of activity (i, j).

LS_{ij} → Latest starting time of activity (i, j).

LF_{ij} → Latest finishing time of activity (i, j).

EF_{ij} → Earliest finishing time of activity (i, j).

Forward pass computation ⇒ zero be the starting time for the project

$(EF)_{ij} = (ES)_{ij} + t_{ij}$

$E_j = \max(E_j + t_{ij})$

⑤ Backward pass

assume $[\Sigma F_{ij}] =$

⑥ total

② Time management : planning and scheduling tasks effectively to meet deadlines and avoid delays.

③ Budget management : Controlling costs and ensuring the project stays within the allocated budget.

④ Resource ~~allocation~~ management : Efficiently utilizing human, material and financial resources to maximize productivity.

⑤ Risk management : Identifying potential risks assessing their impact, and implementing reduction strategies.

⑥ Quality assurance : Ensuring that project deliverables meet the required standards and ~~expectations~~.

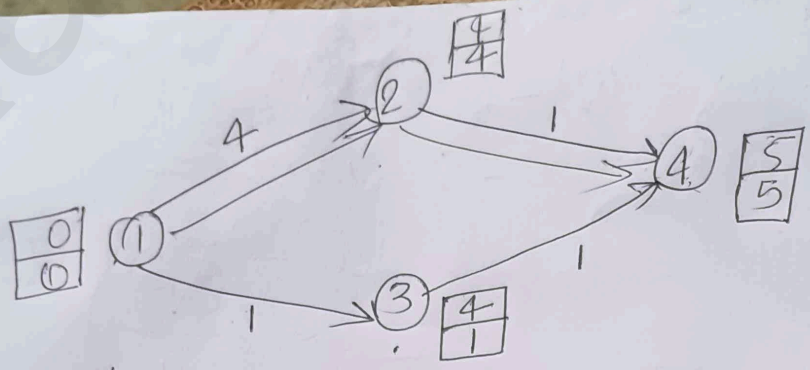
Q6 Name any four software which can be employed for planning and monitoring of a project.

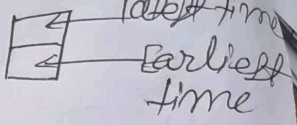
Ans ⇒ Here are four software tools commonly used for project planning and monitoring.

① Microsoft project : A powerful project management tool for scheduling, tracking progress, and resource management.

② Jira : Popular for agile project management, issue tracking, and sprint planning, commonly used in software development.

③ ~~Trello~~ Trello : A simple, visual tool that uses boards and cards for task management and





Critical path : 1 → 2 → 4

Project length = 4+1 = 5

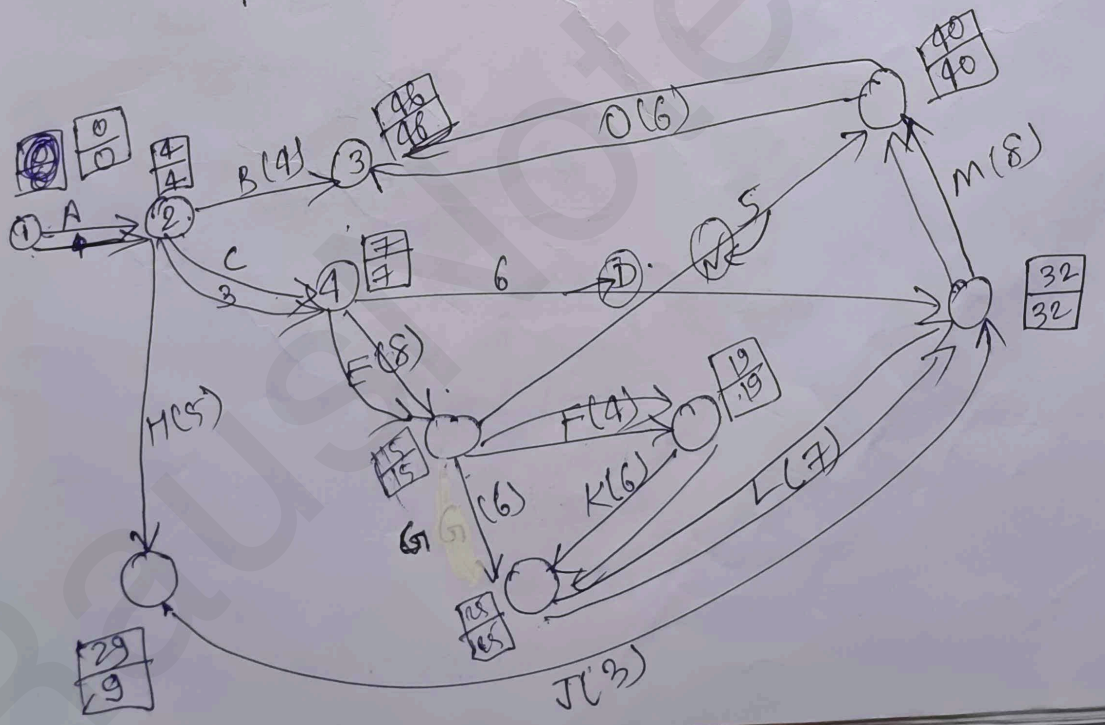
Activity	Time T_{ij} in days	Earliest start (ES) (E_i)	Earliest finish (EF) $E_f = E_i + T_{ij}$	Latest start (LS) $L_S = L_j - T_{ij}$	Latest finish (LF) (L_j)	Total float $(L_S - E_S)$
1–2	4	0	4	0	4	0
1–3	1	0	1	3	4	3
2–4	1	4	5	4	5	0
3–4	1	1	2	4	5	3

E_j	L_i	free float (ff) $E_j - E_i - t_{ij}$	independent float $E_j - L_i - t_{ij}$	interference float $TF - ff$
4				
4	0	4-0-4 = 0	4-0-4 = 0	0
1	0	1-0-1 = 0	1-0-1 = 0	3
5	4	5-4-1 = 0	5-4-1 = 0	0
5	4	5-1-1 = 3	5-4-1 = 0	0

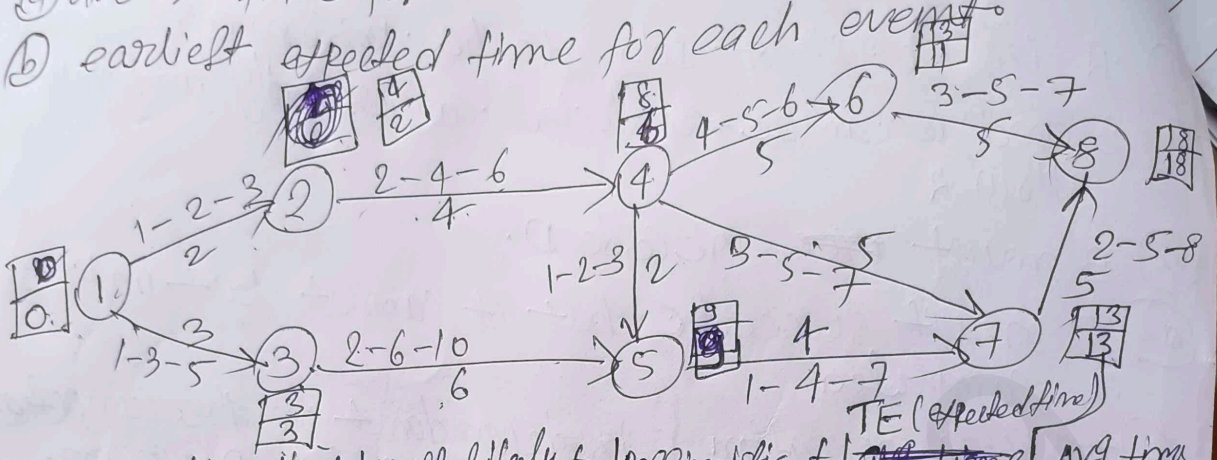
इनमें से अगर कोई भी (-ve) आता है तो उसको 0 लिख सकते हैं।

(10) Draw the network and determine critical path

Activity	preceded by	Duration (Days
A	—	4
B	A	6
C	A	3
D	C	6
E	C	8
F	E	4
G	E	6
H	A	5
J	H	3
K	F	6
L	G, K	7
M	D, J, L	8
N	E	5
O	M, N	6



Eg① The three time estimates are given for the project shown below. calculate
(a) average time for each event.
(b) earliest expected time for each event.

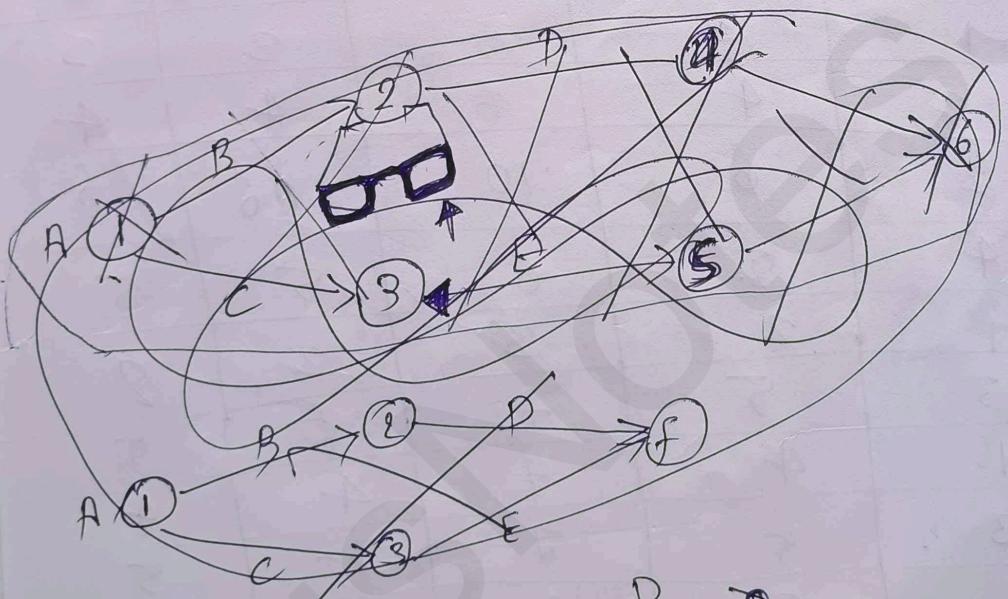


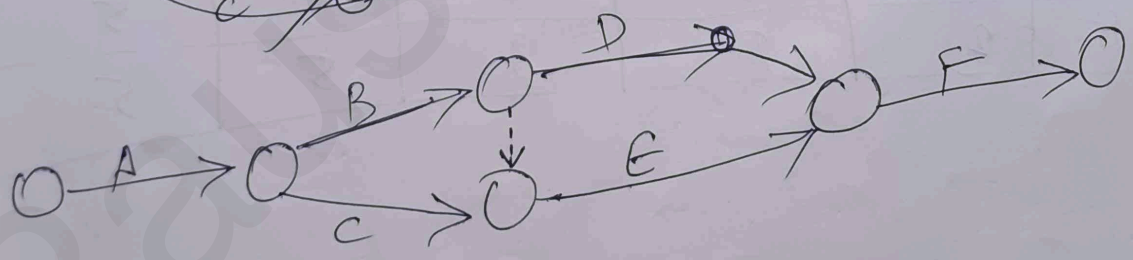
Activity	Optimistic time t_o	Most likely time t_m	Pessimistic time t_p	TE (expected time) $t_e = \frac{o+4m+p}{6}$	AVG time $\frac{o+m+p}{3}$
1-2	1	2	3	$\frac{1+4\times2+3}{6} = 2$	2
1-3	1	3	5	3	3
2-4	2	4	6	4	4
3-5	2	6	10	6	6
4-6	4	5	6	5	5
4-5	1	2	3	2	2
4-7	3	5	7	5	5
5-7	1	4	7	4	4
6-8	3	5	7	5	5
7-8	2	5	8	5	5

Pyqs mgt

qn
(Pyq) A project consists of six (6) activities designed from A to f. with the following relationship

(1) A is the first job to be performed.
(2) B and C can be conducted concurrently and must follow A
(3) B must precede D.
(4) E must succeed C, but it cannot start until B is completed
(5) The last operation F is dependant on the completion of both D and E Draw the network Diagram.





it eases to monitor

path 1:

1: A → B → O ⇒ (6)

2: A → H → J → M → O (5+3+8+6) ⇒ (22)

3: A → C → E → G → L → M → O (3+8+6+7+8+6) → (38)

4: A → C → E → F → K → L → M → O (3+8+4+6+7+8+6) → (42)

5: A → C → E → N → O (3+8+5+6) → (22)

6: A → C → D → M → O (3+6+8+6) → (23)

Critical path =

A → C → E → F → K → L → M → O

critical path duration = 42

1-2-5-7 = 7+9+2 = (18)
1-3-5-7 = 5+5+2 = 12
1-3-6-7 = 5+6+3 = 14
1-4-6-7 = 8+7+3 = (18)

→ Critical path (max)

Normal project completion time = 18 weeks

Total cost = normal direct cost + indirect cost
Total cost = 6500 + 200 (given in question) × 18
Total cost = 10100

crash limit and slope → Normal time - crash time

critical path	critical activity	crash limit	cost slope
1-2-5-7	1-2	(3) 2	(50) 1st
	2-5	2	125
	5-7	1	100
1-4-6-7	1-4	3	200
	4-6	(2) 1	(125) and
	6-7	1	350

Note: whom ever we have the minimum cost slope that activity we have to crash first

slope cost of crashed activity = 50+125

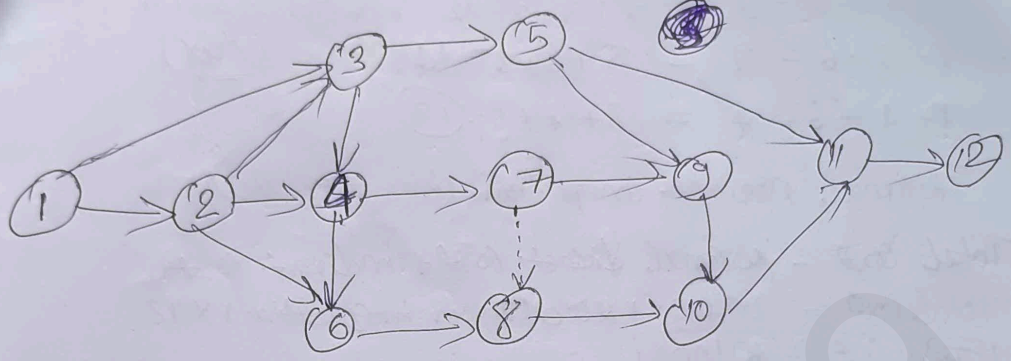
II - Iteration
Critical path: 1-2-5-7 ⇒ 6+9+2 = (17)
1-3-5-7 ⇒ 5+5+2 = 12
1-3-6-7 ⇒ 5+6+3 = 14
1-4-6-7 ⇒ 8+6+3 = (17)

→ Critical path

∴ Project com time = 17 weeks

Total cost = Pre. Total cost + direct cost (slope cost) - indirect cost
Total cost = 10100 + (50+125) - (200×1) = 10075/-

following



* Crashing of project Network

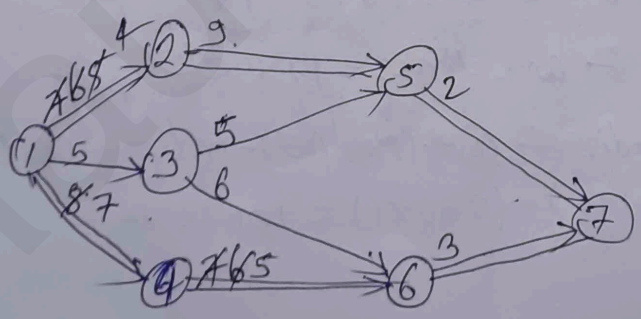
Consider the data of a project as shown in the table

Activity	Normal Time (weeks)	Normal cost	Crash time	Crash cost	cost slope = $\frac{\text{crash cost} - \text{normal cost}}{\text{normal time} - \text{crash time}}$
1-2	7	700	4	850	50
1-3	5	500	3	700	100
1-4	8	600	5	1200	200
2-5	9	800	7	1250	225
3-5	5	700	3	1000	150
3-6	6	1100	5	1300	200
4-6	7	1200	5	1450	125
5-7	2	400	1	500	100
6-7	3	1500	2	850	350

If the indirect cost per week is Rs 200; find the optimal crashed project completion time.

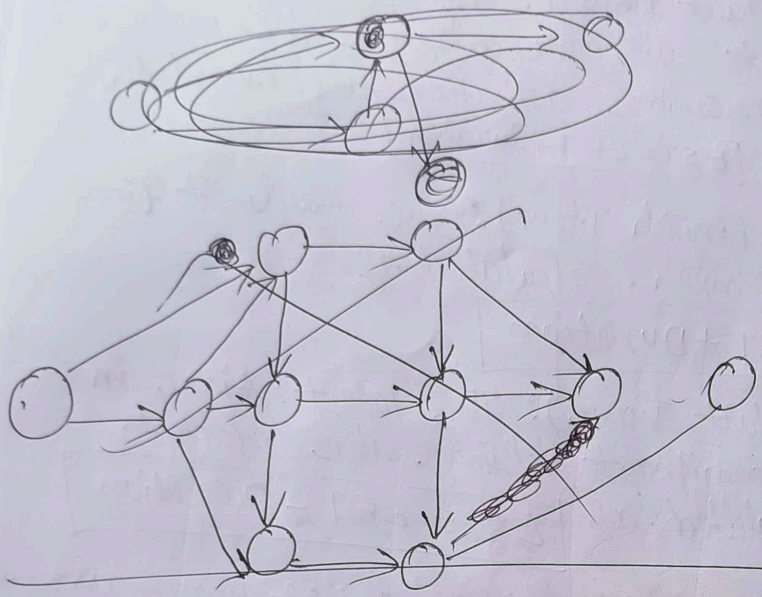
I - Iteration

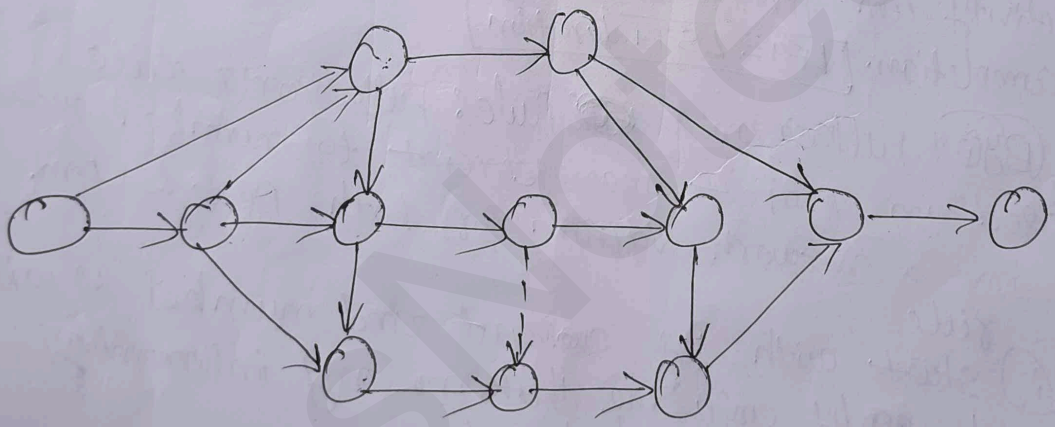
Σ normal cost = 6500



Find critical path

(Pg 8) Number the events for the following network using D.R Fulkerson's rule





PYQ Brief the terms EST, EFT, LST, LFT in project management

① EST (Earliest Start Time): The earliest time an activity can start without delaying the project, assuming all preceding activities are completed as soon as possible [EST = EFT - duration]

② EFT (Earliest Finish Time): The earliest time an activity can finish, calculated as [EFT = EST + Duration]

③ LST (Latest Start Time): The latest time an activity can start without delaying the project completion, calculated as [LST = LFT - Duration]

④ LFT (Latest finish Time): The latest time an activity can finish without delaying the project completion. [LFT = LST + duration]

PYQ Fulkerson's Rule: Fulkerson's rule used in project management to number events in a network diagram for both Pert & Cpm.

Rule

(i) Start with 1st event and number it with 1 by ensuring that no any incoming arrow is that node / event.

(ii) After that all the nodes that are connected to start node eliminate all outgoing edges from starting node and number the nodes

(iii) Repeate this step till end.

Crash Limit and Slope

Critical path	critical activity	Crash Limit	cost slope
1-2-5-7	1-2	(2) 1	(50)
	2-5	2	225
	5-7	1	100
1-4-6-7	1-4	3	200
	4-6	(1) 0	(125)
	6-7	1	350

Minimum cost slope (Crash it)

III iteration

CP ⇒ 1-2-5-7 = 5+9+2 = (16)
1-3-5-7 = 5+5+2 = 12
1-3-6-7 = 5+6+3 = 14
1-4-6-7 = 8+5+3 = (16)

CP

∴ Project comp time = 16 weeks

Total cost = Prev cost + (cost slope) - indirect cost

Total cost = 10075 + (50+125) - (200×1) = 10050

Critical Path	Critical activity	Crash limit	cost Slope
1-2-5-7	1-2	(1) 0	(50)
	2-5	2	225
	5-7	1	100
1-4-6-7	1-4	(3) 2	(200)
	4-6	0	125
	6-7	1	350

we cannot crash activity less than 0

IV Iteration

CP ⇒ 1-2-5-7 = 4+9+2 = (15)
1-3-5-7 = 5+5+2 = 12
1-3-6-7 = 5+6+3 = 14
1-4-6-7 = 7+5+3 = (15)

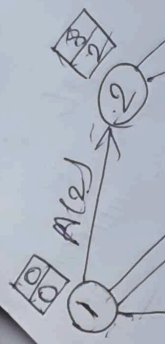
Project comp time = 15 weeks

total cost = 10050 + (50+200) - (200) = 10100

Final Result: Since the total cost of this iteration (IV) is more than that of the previous iteration, stop the procedure and ~~treat~~ the soln of the previous iteration (III) as the best soln for implementation.

The final crashed project completion time is 16 weeks corresponding critical paths are

1 – 2 – 5 – 7 and 1 – 4 – 6 – 7 optimal cost = 10080



Q1. cr.

CPM

Q. Consider the details of a project as shown in the table

Activity	Immediate predecessor(s)	Duration (month)
A	—	2
B	—	5
C	—	4
D	B	5
E	A	7
F	A	3
G	B	3
H	C,D	6
I	C,D	2
J	E	5
K	F,G,H	4
L	F,G,H	3
M	I	12
N	J,K	8

(a) Construct the CPM network.
(b) Determine the critical path and project completion time
(c) Complete total floats and free floats for non-critical activities.

⑤ Recurring costs: Costs that occur regularly throughout the project lifecycle.

Example: • Monthly salaries
• Maintenance charges
• Subscription services

⑥ Non-Recuring costs: One-time costs that occur only once during the project.

Example: • Equipment purchase
• Initial setup fees

(PYQ) Explain the difference b/w Direct and Indirect cost.

features	Direct cost	Indirect Cost
Definition	Cost directly related to a specific project	cost not linked to one project but common to many
Trace-ability	Easily traceable to a single project	Not easily traceable to a single project
Existence	Exists only if the project exists.	Exists even if a project doesn't exist
Examples	Labor wages, raw materials equipment hire	office rent, electricity, admin salaries
project Specific?	Yes, specific to one project	No, shared among all projects
Control & monitoring	Often vari Easier to Control and monitor	Harder to control and allocate.
Cost nature	often variable (depends on project size).	often fixed or semi-fixed
Budgeting Import-ance	Directly affects unit cost and pricing.	Affects overhead and profitability.

Cost Analysis

(Q) what is cost, types of costs

ans → cost refers to the monetary value of all resources required to complete a project or a task. It includes the expenditure on materials, labor, equipment, services, and overheads necessary to achieve project goals.

Types of costs

① Direct costs: These are costs that can be directly attributed to a specific project or activity.

Example: • Labor Wages
• Raw materials
• Equipment used specially for the project

② Indirect costs: Costs that are not directly accountable to a specific project but are necessary for the organization's overall operation.

Example: • Administrative expense
• Utilities
• office rent
• Salaries of admin staff or HR team.

③ Fixed cost: Costs that do not change with the level of project output.

Example: • Rent for project office
• Salaries of staff
• Insurance

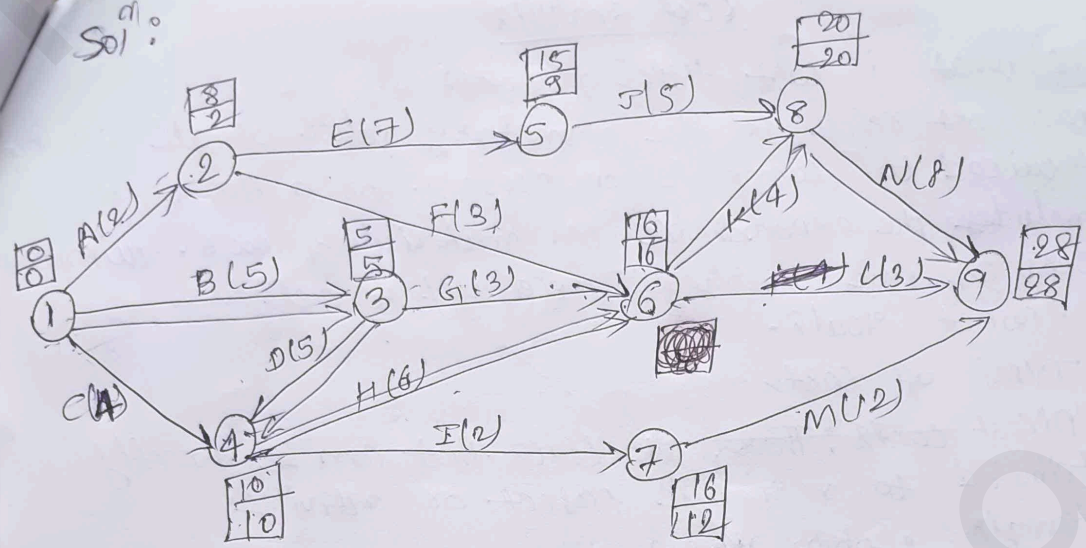
④ Variable costs: costs that vary directly with the level of production or project activity.

Example: • Raw Material
• wages of hourly ~~labo~~ labor
• fuel for machinery.

⑤ Recurring costs throughout the

⑥ Non

Sol^{n}:

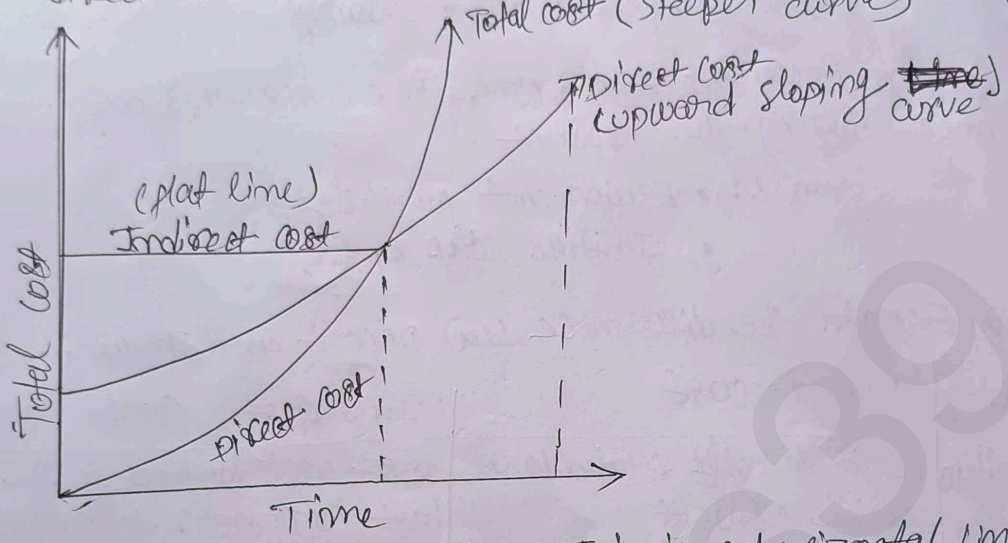


Critical path: 1 — 3 — 4 — 6 — 8 — 9

Project completion time = 5 + 5 + 6 + 4 + 8 = 28 Months

(PYQ) Define the term 'direct cost' & 'indirect cost'. Draw the total cost curve and show on it how direct and indirect cost vary with time.

ans ⇒ direct and indirect cost have already done.



1. Indirect cost Line (flat Line): This is a horizontal line. It shows that indirect costs remain constant over time. These include office rent, salaries of admin staff, etc.

2. Direct cost curve (upward sloping Line): This line increases with time, it shows that as the project progresses, more direct costs are incurred, such as labor, materials.

3. Total cost curve (steeper curve): This is the sum of direct + indirect costs, starts higher due to the base indirect cost and rises faster than the direct cost line. It shows the actual total cost of project over time.

(PYQ) Define 'crash time', 'crash cost', 'direct cost', define 'normal project time', 'normal cost', indirect cost and outage cost.

Steps: Document the changes: Record all changes and reasons for future reference and audit...

Necessity of the updating process | why it is essential

(i) Tracks Real Progress: Keeps a real-time check on how the project is performing compared to the original plan.

(ii) Enables Timely Decisions: Helps managers identify issues early and take corrective action.

(iii) Controls cost and Time overruns: Detects overspending or delays, allowing for adjustments before it's too late.

(iv) Improves Resource Management: Shows where resources are over or underutilized.

(v) Supports Forecasting: Helps predict the project's future direction and make informed decisions.

(vi) Keeps stakeholders informed: Builds transparency and trust through regular updates and clear communication.

(pyq) what do you understand by updating? why is it essential.

why is updating Essential..

Updating is important for the following reasons.

(i) Tracks real progress of the project.
(ii) Detects delays and cost overruns early.
(iii) Helps in decision-making for corrections and improvements
(iv) Improves time and cost control.
(v) Ensures efficient use of resources.
(vi) Forecasts future performance.
(vii) Keeps stakeholders informed.
(viii) Avoids last-minute surprises of failure.
(ix) Maintains transparency and accountability.

⑥ Indirect cost : Already Done

⑦ Outage Loss: Outage loss is the loss faced due to delays or stoppages in project work or production. It is non-technical cost but impacts project profit and success significantly.

(PYQ) Discuss the process of updating, what is necessity of updating process?

ans ⇒ project updating is the process of reviewing and revising the project plan to reflect the actual progress, changes in schedule, cost, or resources as the project moves forward. It helps keep the project on track and ensures that decisions are made based on current and real-time information.

Discuss the process of updating

Step1 : Collect Actual Data: Gather data on work completed, actual start/finish dates, resources used, and costs incurred.

Step2: Compare with Baseline plan: Evaluate current status with original schedule and cost estimates.

Step3: Identify variance/delays: Highlight differences in time, cost, and resources

Step 4 : Re-schedule Activities: Modify the schedule to reflect new timelines, adjust dependencies and shift deadlines.

Step 5: update costs and Budgets: Revise cost estimates and track budget consumption.

Step 6: Review Resource usage: Monitor whether labour, equipment and materials are being used efficiently.

Step 7: Communicate changes: Inform the project team and stake holders about the updated plan and impact on delivery.

1. Crash Time: Crash time is the shortest possible time in which a project activity can be completed by using extra resources like additional labor, equipment or overtime. used when the project deadlines is tight and faster completion is required.

Example: If an activity normally takes 10 days, but with extra workers it can be done in 6 days then crash time = 6 days.

(2) Crash cost: crash cost is the increased cost of completing an activity in its crash time. This includes additional expenses due to overtime, extra labor, machinery etc. Crash cost is higher than the normal cost due to the extra resources used.

Example: If the normal cost is ₹ 10,000 and the crash cost is ₹ 14,000, then the extra ₹ 4000 is spent to complete the activity earlier.

(3) Direct cost: Already Done

(4) Normal project time: This is the standard or planned time required to complete an activity, without any urgency or extra effort. It assumes normal resource usage, no overtime, and no cost increase.

Example: If a task usually takes 10 days under normal working conditions, the normal time = 10 days

(5) Normal cost: This is the cost incurred to complete an activity in its normal time using standard resources.

Example: If a task normally takes 10 days and costs ₹ 10,000 then 10,000 is the normal cost.

what is done and what is remaining.

(v) Identify critical Activity: Tools like cpm help find critical paths that must not be delayed.

(vi) Improves coordination: Teams work better when everyone knows the schedule.

(vii) Reduces cost overruns: Timely execution reduces idle time and unnecessary expenses.

(PYQ) write short Notes on Resource scheduling

Resource scheduling is the process of assigning available resources (like labor, machines, materials and money) to project activities in an efficient and timely ~~manner~~ manner so that the project is completed on schedule and within budget.

It ensures that

(i) No resource is overloaded or underutilized

(ii) Activities are completed without delay due to lack of resources.

(iii) project costs are controlled by optimal use of resources.

objectives of Resource scheduling.

(i) To allocate resources according to project priority.

(ii) To avoid conflicts or double booking of the same resource.

(iii) To reduce idle time and resource wastage

(iv) To ensure timely completion of critical tasks.

Q. Define the term scheduling and what are the different phases of scheduling?

ans ⇒ Scheduling in project management refers to the process of planning the sequence, timing, and duration of project activities to ensure the project is completed within the given time frame. It ensures that all activities are done in the right order, with the right resources and within the right time.

phases of scheduling:

phase (1): planning phase: Define project tasks, work breakdown structure and identify activities.

(2.) Sequencing phase: Decide the logical order of activities and identify dependencies.

(3.) Time Estimation phase: Estimate the duration required for each activity.

(4) Resource Allocation phase: Assign resources (manpower, machines, materials) to each activity.

(5) Schedule Development phase: Use tools like Gantt charts, CPM or PERT to create a schedule.

(6) Monitoring and updating phase: Track progress and revise the schedule as needed based on actual performance.

(Pts) Discuss the advantages of scheduling

(i) Better Time Management: Helps plan and complete tasks within deadlines.

(ii) Efficient Resource utilization: Ensures manpower, materials and machines are used optimally.

(iii) Clear workflow: Provides a logical sequence of activities, reducing confusion.

(iv) Helps in Tracking progress: Makes it easier to monitor

(PYQ) Enlist and discuss the factors governing for updating the project with a suitable example.

ans → key factors that govern project updating

1. project progress: updates depend on the actual % of work completed.
2. Time delays: Any delays due to weather, labor issues, etc require schedule updates.
3. cost variations: changes in material, labor or fuel can affect the budget and need to be updated.
4. Resource Availability: If manpower or machines are not available on time, updates are needed.
5. change in scope: If client demands extra features or changes, the schedule and cost must be revised.
6. Risk occurrence: Unexpected problems like strikes or supply issues must be updated in the plan.
7. Quality Issues: Rework due to poor quality can affect timelines and needs to be reflected.

Example: Suppose you're managing a bridge construction project. Due to heavy rain, concrete pouring is delayed by 5 days, and cost of materials has increased. Also, one crane broke down, delaying lifting work.

In this case:

- you must update the schedule to shift tasks forward by 5 days.
- you need to update the costs as the material prices went up.
- you must reallocate resources due to the crane failure.

Technology used → Gantt Chart, CPM, Resource Leveling, Resource Smoothing,

Example:

If 2 machines are available but 3 tasks need them at the same time, resource scheduling helps in adjusting task timing so each machine is used without delay.

MST-PYQ

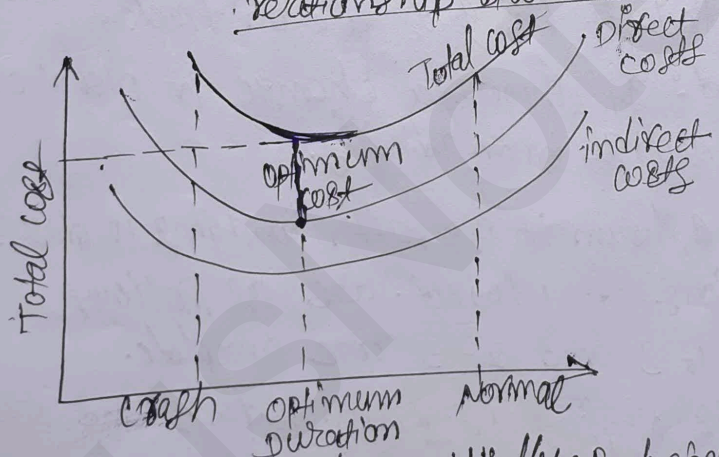
Q1. What is relation b/w optimum duration and optimum cost of a project?

Ans ⇒

Optimum Duration: Optimum duration is the shortest project duration that can be achieved without incurring unnecessary extra costs. It is the point where the project is completed efficiently.

optimum cost: Optimum cost is the lowest possible cost including direct and indirect cost needed to complete the project at the optimum duration.

relationship b/w both (Time cost Trade-off)



(i) Inverse relationship initially: Reducing project duration typically increases direct costs.

(ii) U-shaped total cost curve: plotted graph b/w total cost and project duration typically forms a U-shape.

- Left side: high direct cost
- Right side: high indirect cost
- Bottom of the U: optimum point lowest total cost for a specific duration.

This point gives both the optimum duration and the optimum cost.

(pyq) How frequently is updating carried out in a project? or when to update.

ans ⇒ updating is typically carried out regularly and as needed depending on the project's complexity, duration and methodology.

(i) Daily: Small team meeting to check progress called (Stand-ups).

(ii) Every week: Share progress reports with the manager or team

(iii) Every 2 weeks: Review what was done, plan what to do next, discuss how to improve teamwork.

(iv) Every month: check if big goals are on track.

(v) Anytime Needed: If there is a change in plan or a problem, update things immediately.

(pyq) for a network shown in fig, after working 12 days on project, the conditions of project are as follows

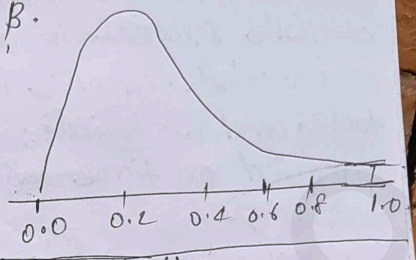
(a) Activities 1-2, 1-3 and 2-3 are complete.

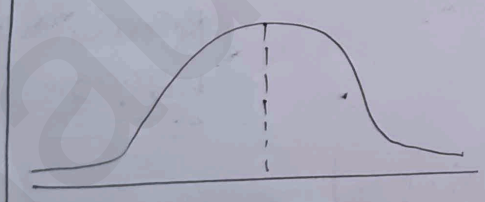
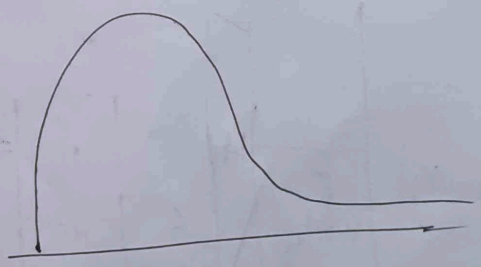
(b) Activities 2-4 is progressing from 3 days and require 4 more days for completion.

(c) Activity 3-5 is progressing from 4 days and require 8 more days for completing.

(d) Activity 4-5 is reassessed to complete in 10 days.

Beta Distribution curve: The beta distribution is a flexible, continuous probability distribution curve defined on the interval [0, 1]. It is often used to model probabilities and proportions. Total area under the curve is 1. It can be symmetric, skewed, U-shaped, or uniform. depending on the values of α and β.



Features	Normal Distribution	Beta Distribution
Shape	Symmetrical, bell-shaped	Flexible: can be symmetrical or skewed (left/right).
Range of values	$-\infty \longleftrightarrow +\infty$ ~~undefined~~ infinite range	[0, 1] Limitted
Defined by	Defined by mean (μ) and standard deviation (σ)	defined by two shape parameter α and β.
Use	Not commonly used PERT.	commonly used in PERT.
Skewness	Always zero	Can be positively or negatively skewed
Tail Behavior	Tails extend indefinitely	Tail are bounded (within 0 and 1)
Usage	When data is unbounded	when data is bounded between 0 and 1.
Graph		

(Q9) what are the objectives of resource planning and resource allocation? Discuss in detail resource smoothing and resource leveling step by step.

and→ (i) Resource planning: Resource planning is the process of identifying, forecasting, and organizing all the necessary resources that are required to complete a project successfully.

objectives of Resource planning

(i) Optimal Resource utilization: To ensure that the all available resources are ~~utiliti~~ utilized efficiently, avoiding underuse or overuse. This helps to minimise cost and maximize productivity.

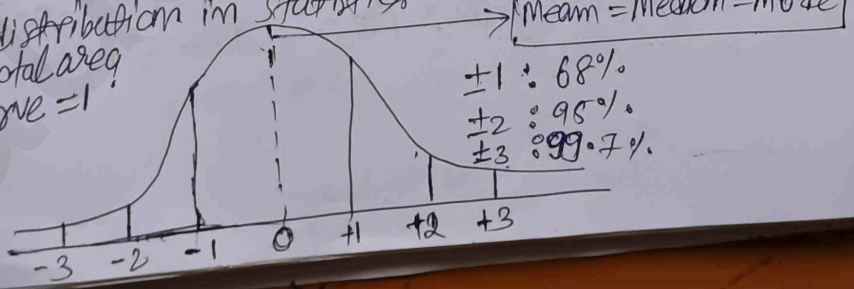
(ii) Resource identification: To identify the resources needed for a project, including manpower, equipment, tools and budget. This helps to understanding project requirement.

(Q10) what is meant by probability distribution curve? Differentiate clearly b/w normal distribution curve and beta distribution.

normal

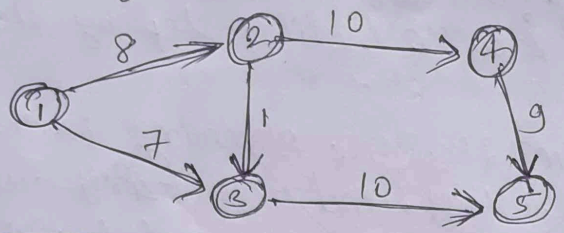
ans ⇒ A normal probability distribution curve, also known as ~~bell shaped curve, is a type of~~ (Gaussian distribution) is a bell-shaped, ~~curve~~ symmetric curve that describes how values of a continuous random variable are distributed. It is ~~the~~ one of the most important probability distribution in statistics.

In this curve total area under the curve = 1



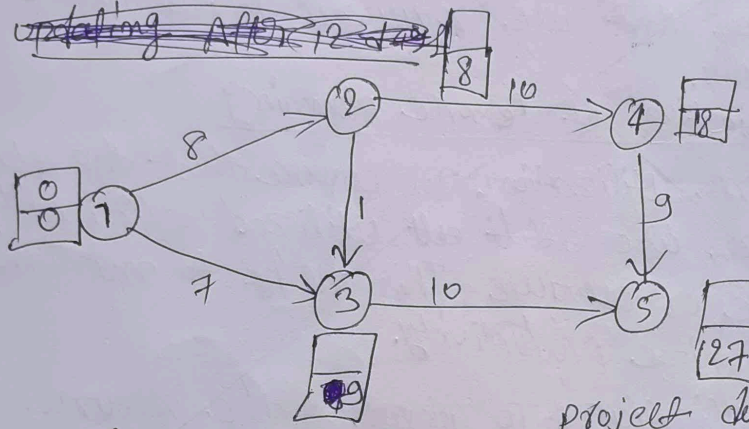
Beta distribution curve: ... flexible, continuous probab... on the interval [0, 1]. ... probabilities and proport... is 1. ... can be sym... depending on the va...

update existing network and also make new network after updating.



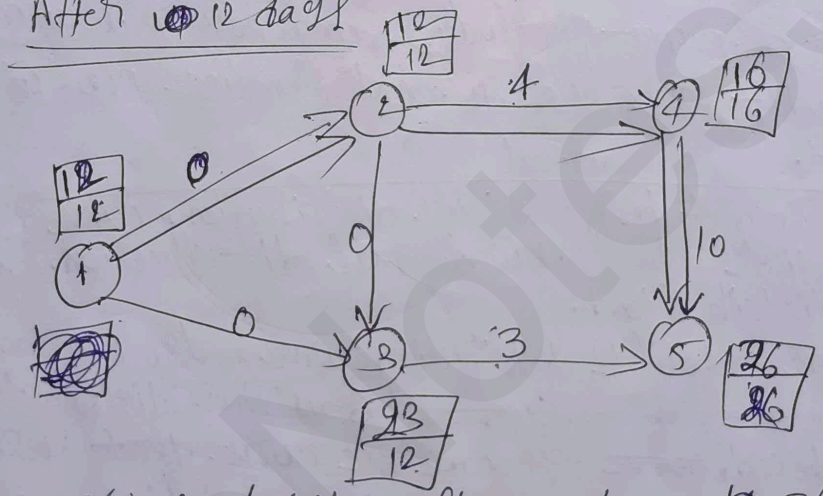
Sol^{n}:

~~updating. After 12 days~~



project duration = 27

After 12 days



Project duration after 12 days = 26

increased project duration = 27 - 26 = 1

critical path: 1 - 2 - 4 - 5

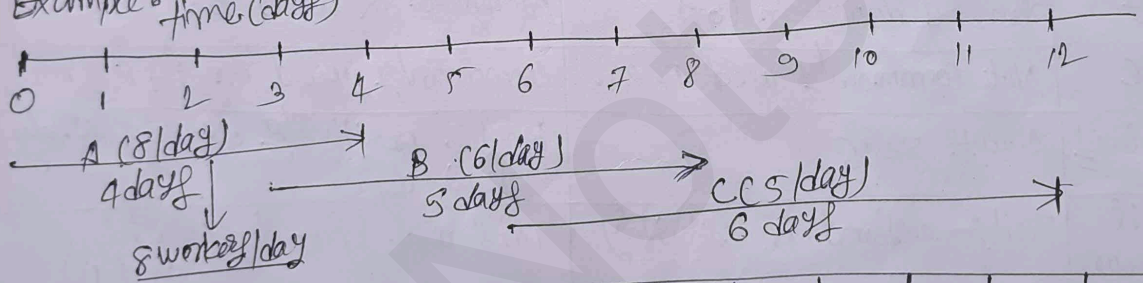
(Q8) Explain the concept of resource allocation in project management. Discuss the different types of resource allocation techniques, including Resource Leveling, Resource Smoothing step by step.

Resource Allocation: Resource allocation is the process of assigning available resources in an efficient manner to complete a project task. Resources can include manpower, equipment, tools, and materials. The objective is to ensure tasks are completed on time without over-allocation or underutilizing resources.

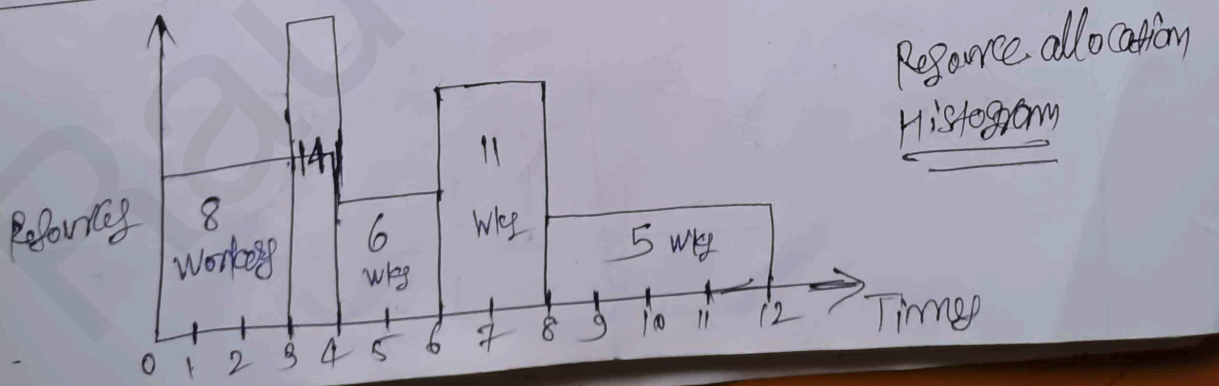
objective of resource Allocation

(i) Ensure optimal use of available resources
(ii) Avoiding resource conflicts.
(iii) Avoiding resource over-allocation or underutilization.
(iv) Ensure completion of project on time.

Example: time (days)



Time (days)	1	2	3	4	5	6	7	8	9	10	11	12
Resources	8	8	8	14	6	6	11	11	5	5	5	5



Resource allocation Histogram

Techniques of Time-Cost optimization

(i) Crashing: It involves reducing the duration of critical activities by deploying additional resources to minimize project duration with the less additional cost.

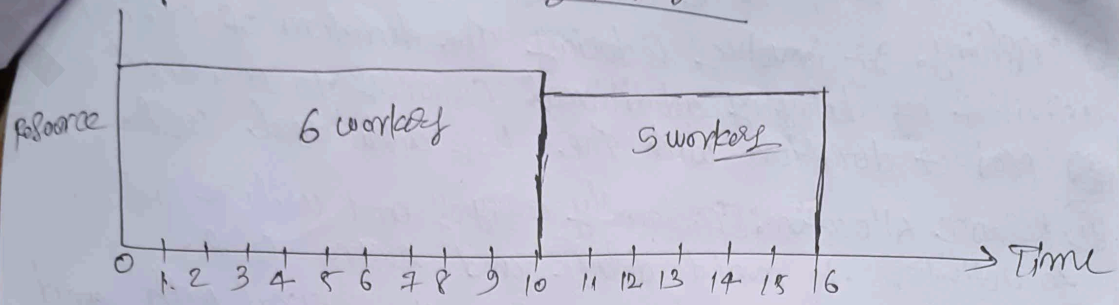
(ii) Resource Allocation: Efficiently assigns and utilize resources to activities to avoid delays and extra cost.

(iii) Analyze project network: Identify the critical path and calculate the cost-slope for each activity.

(iv) Crash activity strategically: Reducing the duration of activities on the critical path with the lowest cost slope.

(v) Balance Direct and Indirect cost: Finding the point where the total cost is minimized.

Resource Leveling Histogram



* what are the objectives of resource planning

Ans ⇒ Resource planning is the process of identifying, forecasting and organizing all necessary resources required to complete a project successfully.

objective of Resource planning

(i) Efficient Resource Utilization: Avoid waste and make full use of available resources in efficient manner.

(ii) Right Resource at Right Time: Ensure workers, materials and tools are available when needed.

(iii) Avoid Resource conflicts: prevent resource overutilization or underutilization to avoid conflicts.

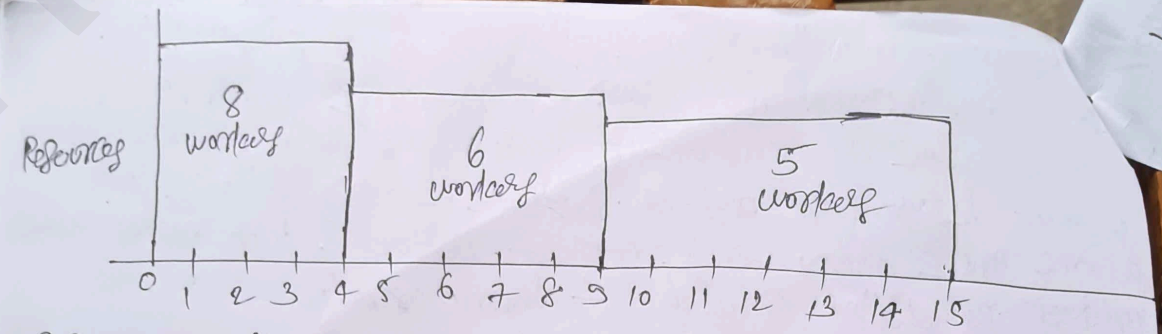
(iv) Control project cost and Time: Manage costs by proper planning and avoid project delays.

(v) Forecast future Resource Needs: Helps in predicting future resources use required in project.

(vi) Risk identification: Identifies resource-related risks such as unavailability of labour, equipment, material.

(vii) Explain the method of time cost optimization of project Network.

Ans ⇒ Time cost optimization is a technique used in project management to minimize the total project cost and reduce project completion time to avoid deadline.



* Resource Leveling: Resource leveling is the process of adjusting the start and finish dates of tasks based on resource constraints, without exceeding the resource availability, in this resource is limited, project duration may change.

Step by Step:

(i) Identify Over-allocated Resources: use Gantt, histograms.

(ii) Analyze task dependencies: understand task relationship to determine which tasks can be rescheduled.

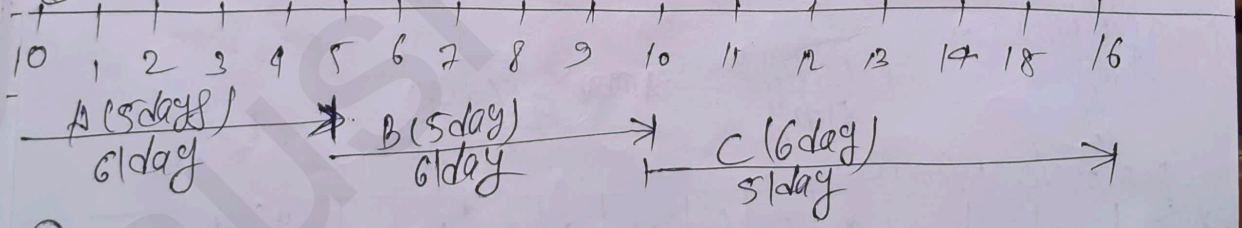
(iii) Extend Tasks: Shift tasks forward to reduce resource conflicts.

(iv) update Schedule: Reschedule the project plan.

(i) A (4 days) → 8/day → (ii) A(5 days) → 6/day
B(5 days) → 6/day → B(5 days) → 6/day
C(6 days) → 5/day → C(6 days) → 5/day

max resource that can be allocated per day = 6

(iii)



(iv)

Time days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Resources	6	6	6	6	6	6	6	6	6	6	5	5	5	5	5	5

Resource Smoothing: Resource Smoothing is the process of adjusting the allocation of resources with their floats values to ensure project completion on time without delaying the project deadline. In smoothing we assume there are infinite no of resources but make sure project completion should not hampered.

Step by steps:

(i) Define Resource Limits: Determine how much of each resources is available during the project.

(ii) Identify Float: Find tasks that can be delayed without delaying the overall project completion time.

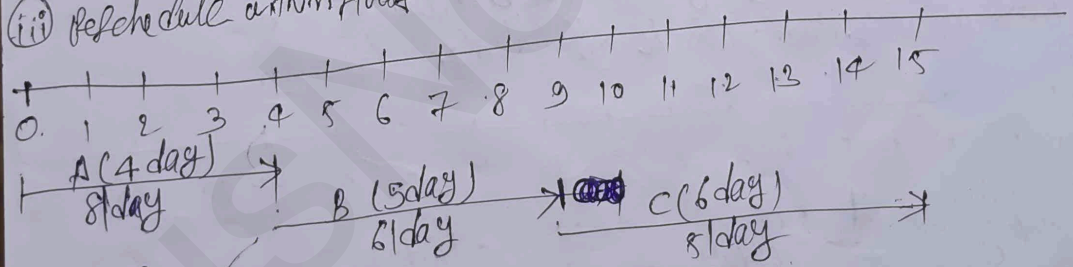
(iii) Reschedule within float: Adjust the start or finish of tasks to smooth resource usage.

(iv) Reallocate Resources: Distribute workloads to avoid resource conflict.

(i) Define resource limit
A (4 days) → 8 l day
B (5 days) → 6 l day
C (6 days) → 5 l day

(ii) identify floats
A → float = 0, B → float = 2, C → float = 3 days

(iii) Reschedule within floats



(iv) Reallocate Resource

days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Resources	8	8	8	8	6	6	6	6	6	5	5	5	5	5	5

Resource Smoothing Histogram