Unit 2

Project Scheduling

PERT

- PERT is a management technique used with responsibility accounting and to attain well defined objectives.
- It is designed for scheduling complex interrelated tasks of the projects.

❖ **PERT System of Three Time Estimate**

- Optimistic Time
- Most likely Time (t_m)
- Pessimistic Time (t_p)

❖ PERT Algorithm

1. Develop a list of activities that made up the project including immediate predecessors.
2. For each activity, a rough PERT network is drawn on the basis of which activity precedes, which activity follows which one, which activity are concurrent with which one.
3. The network is sketched to conform to rules and conventions.
4. Events are numbered in ascending order from left to right.
5. Time estimates (Optimistic Estimate, Most Likely Estimate, Pessimistic Estimate)for each activity are obtained.
6. Then upon the assumption of beta distribution for the activity duration, the expected time te for each activity is computed using te = 1(1+4m+b)/6.

❖ **PERT Algorithm…(continued)**

7. Using the expected activity time estimates, determine the earliest start time and the earliest finish time for each activity, the earliest finish time for the complete project corresponds to the earliest finish time for the last activity.
8. After determining the latest start time and the latest finish time for each activity, compute the float associated with each activity, the critical path activities are the activities with zero float. Determine now the critical path through the given network.
9. Using the values for b and a, which were determined in step 5. calculate the variance (σ^2) of each activities time estimated by $\sigma^2 = [1(b-a)/6]^2$.
10. Use the variability in the activity times to estimate the variability of the project completion date, then using this estimate compute the probability of meeting a specified completion date by using the standard normal equation

– $Z = \frac{\text{Due date} - \text{Expected date of completion}}{\sqrt{\text{Project Variance}}}$

– where Z = no of standard deviations the due date or target date lies from the mean or expected date

CPM

- CPM method is developed by E. I. du Pont de Nemours Company (USA) in 1958.
- It is used to schedule and control the project.
- It is used to estimate the total project duration and to assign starting and finishing times to all activities involved in the project.

❖ **CPM Systems**

- Activity-On-Arrow (AOA) Network
- Activity-On-Node (AON) Network

❖ Steps

1. Break down the project into various activities systematically. Label all activities. Arrange all the activities in logical sequence. Construct the network diagram.
2. Number all the nodes (events) and activities. Find the time for each activity considering it to be deterministic. Indicate the activity times on the arrow diagram.
3. Calculate earliest start time, earliest finish time, latest start time and latest finish time. Tabulate activity normal times, earliest times and latest times.
4. Determine the total float for each activity by taking difference between the earliest time and latest time for each node.
5. Identify the critical activities and connect them with the beginning node and the ending node in the network diagram by double line arrow. This gives the critical path.
6. Calculates the total project duration.
7. Reduce the total project duration, crash the critical activities of the network.
8. Optimize the cost.
9. Update the network and smooth the network resource.

S.No.	PERT	CPM
1.	PERT is that technique of project management which is used to manage uncertain (i.e., time is not known) activities of any project.	CPM is that technique of project management which is used to manage only certain (i.e., time is known) activities of any project.
2.	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.
3.	It is a probability model.	It is a deterministic model.
4.	It majorly focuses on time as meeting time target or estimation of percent completion is more important.	It majorly focuses on Time-cost trade off as minimizing cost is more important.

S.No.	PERT	CPM
5.	It is appropriate for high precision time estimation.	It is appropriate for reasonable time estimation.
6.	It has Non-repetitive nature of job.	It has repetitive nature of job.
7.	There is no chance of crashing as there is no certainty of time.	There may be crashing because of certain time boundation.
8.	It doesn’t use any dummy activities.	It uses dummy activities for representing sequence of activities.
9.	It is suitable for projects which required research and development.	It is suitable for construction projects.

Problems on PERT (Program Evaluation & Review Technique) & CPM (Critical Path Method)

PERT

- **Problem 1: A small project consisting of eight activities has the given characteristics:**

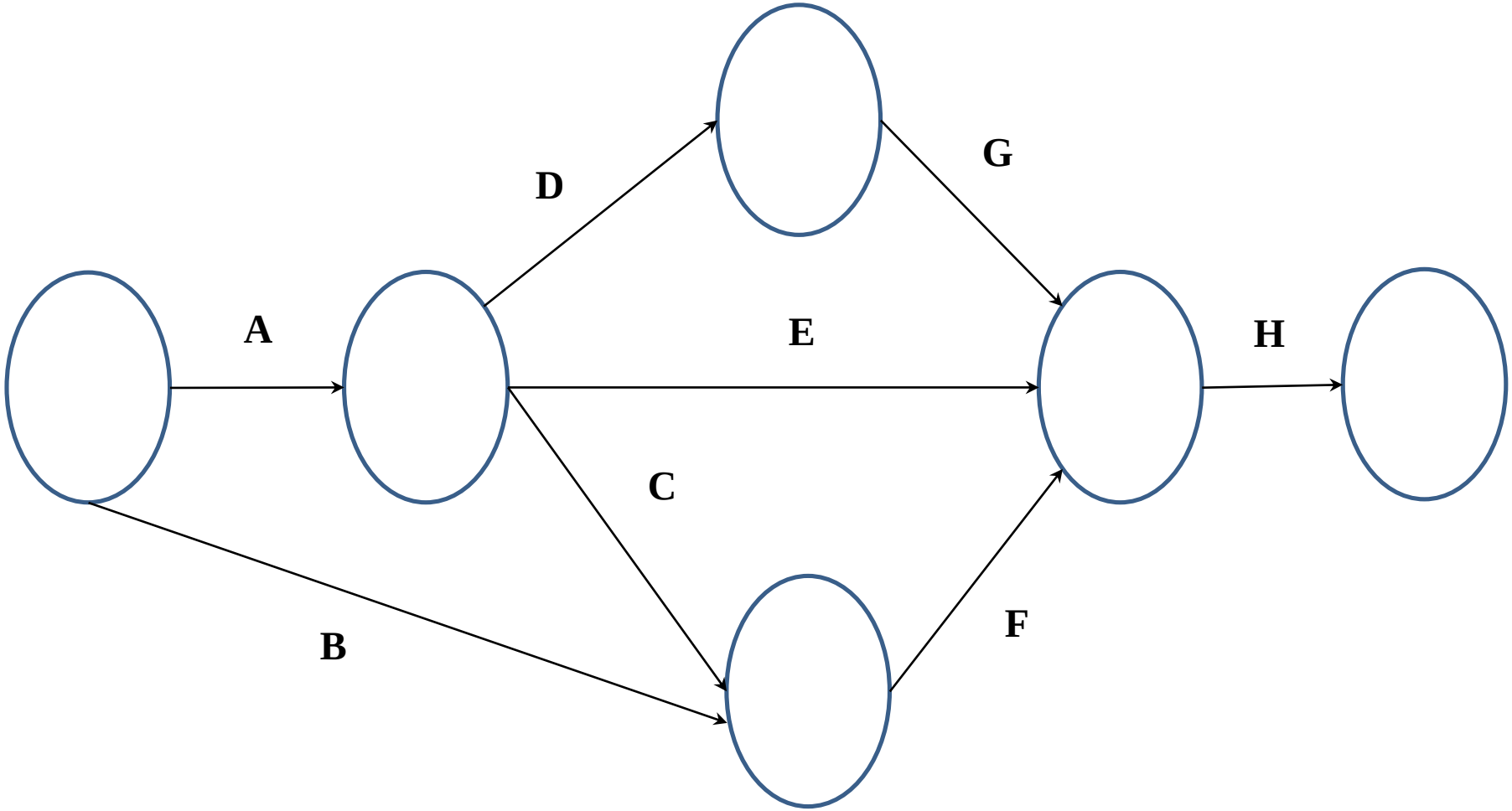
1. Draw the PERT network for the project.
2. Prepare the activity schedule for the project.
3. Determine the critical path.

PERT

Activity	Preceding Activity	Optimistic Time	Most Likely Time	Pessimestic Time
A	None	2	4	12
B	None	10	12	26
C	A	8	9	10
D	A	10	15	20
E	A	7	7.5	11
F	B, C	9	9	9
G	D	3	3.5	7
H	E, F, G	5	5	5

PERT

1. Draw the PERT network for the project.



PERT

2. Prepare the activity schedule for the project.

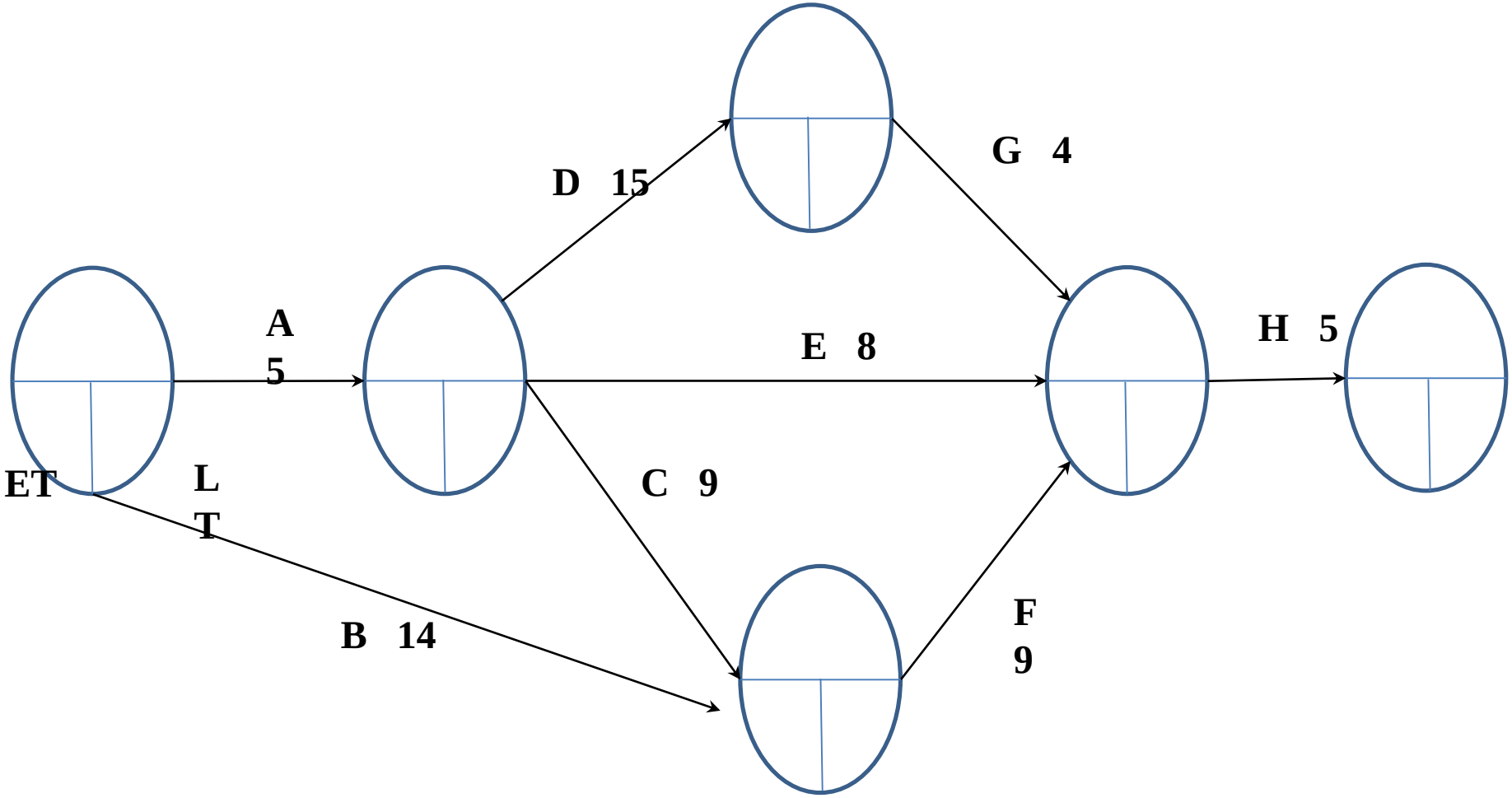
Activity	Preceding Activity	Optimistic Time (a)	Most Likely Time (m)	Pessimestic Time (b)	Expected Time $te = \frac{a+4m+b}{6}$	Variance $\sigma^2 t = ((b-a)/6)^2$
A	None	2	4	12		
B	None	10	12	26		
C	A	8	9	10		
D	A	10	15	20		
E	A	7	7.5	11		
F	B, C	9	9	9		
G	D	3	3.5	7		
H	E, F, G	5	5	5		

PERT

2. Prepare the activity schedule for the project.

Activity	Preceding Activity	Optimistic Time (a)	Most Likely Time (m)	Pessimestic Time (b)	Expected Time $t_e = \frac{a+4m+b}{6}$	Variance $\sigma^2 t = ((b-a)/6)^2$
A	None	2	4	12	5	25/9
B	None	10	12	26	14	64/9
C	A	8	9	10	9	1/9
D	A	10	15	20	15	25/9
E	A	7	7.5	11	8	4/9
F	B, C	9	9	9	9	0
G	D	3	3.5	7	4	4/9
H	E, F, G	5	5	5	5	0

PERT



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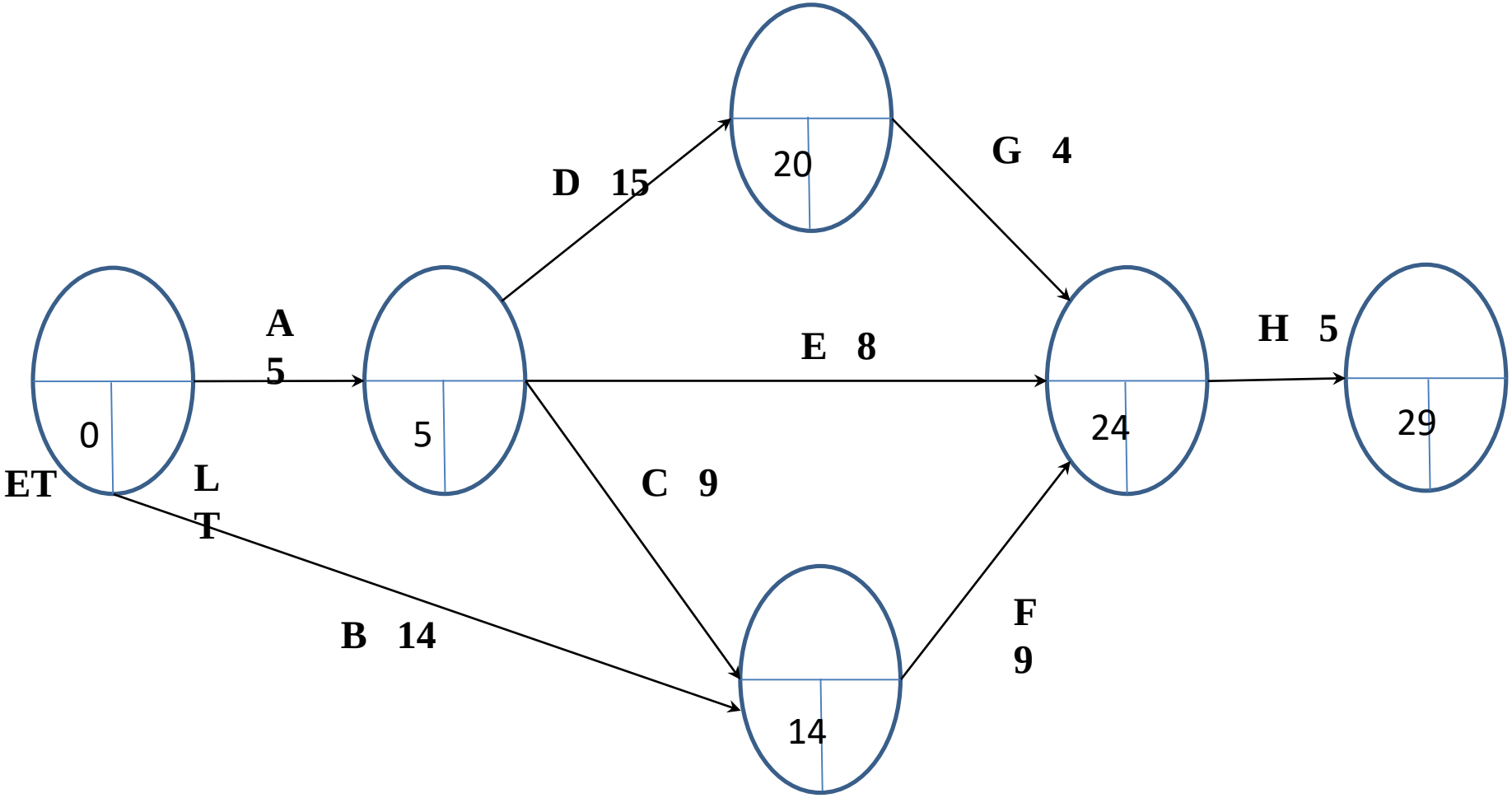

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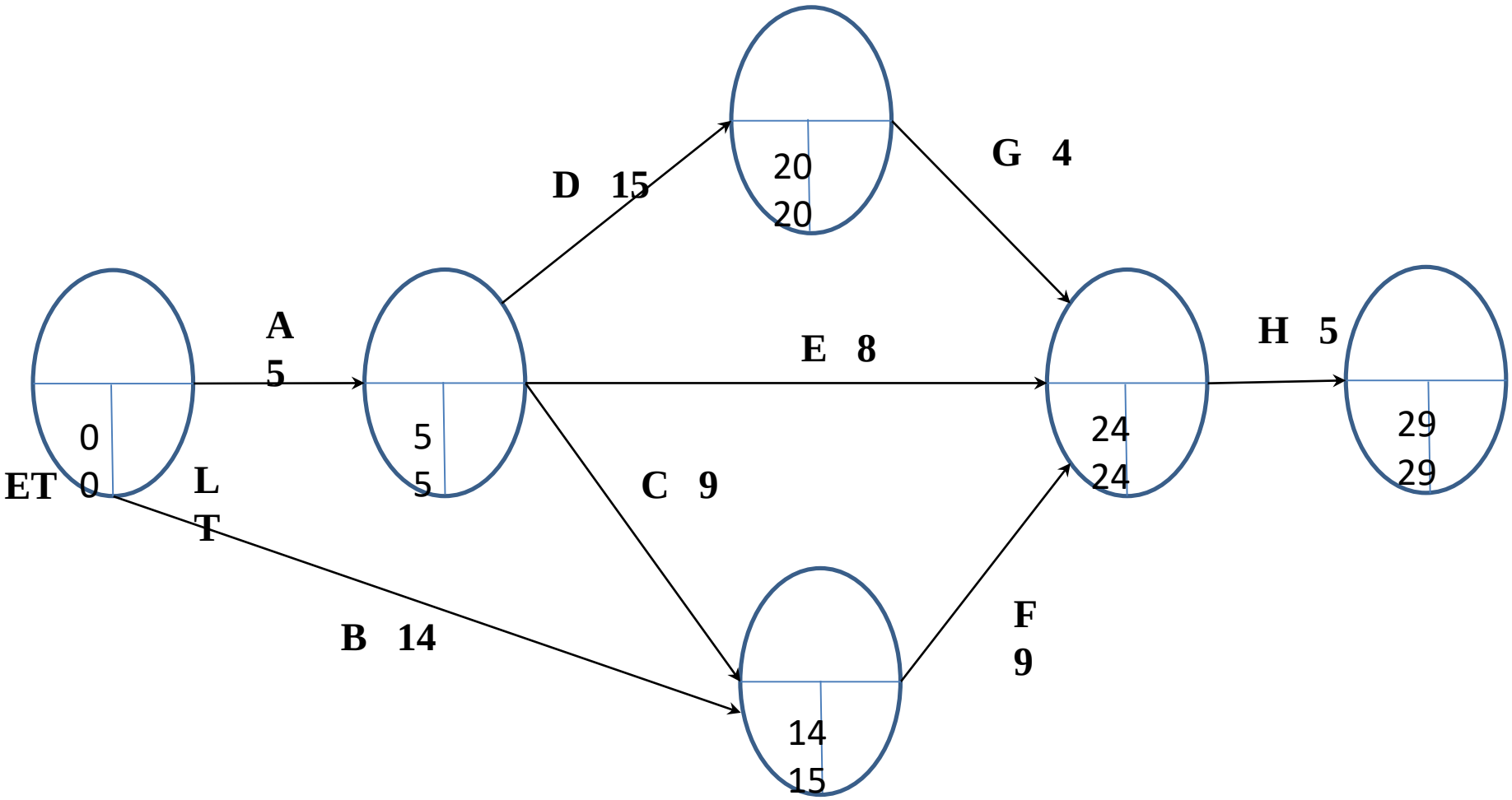

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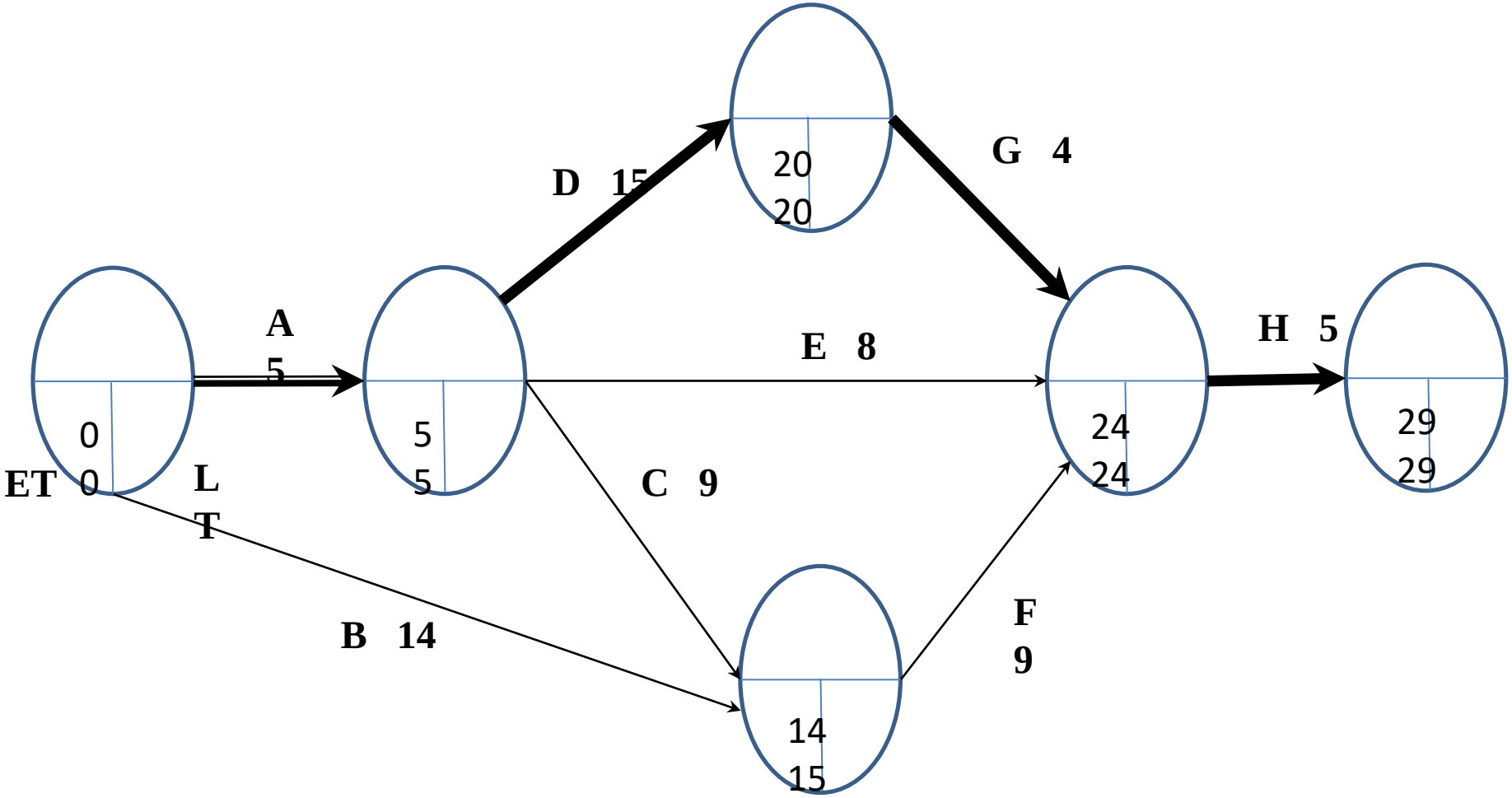


PERT

Activity	Preceding Activity	Optimistic Time (a)	Most Likely Time (m)	Pessimestic Time (b)	Expected Time Te	Variance $\sigma^2 t$	EST	EFT	LST	LFT
A	None	2	4	12	5	25/9	0	5	0	5
B	None	10	12	26	14	64/9	0	14	1	15
C	A	8	9	10	9	1/9	5	14	6	15
D	A	10	15	20	15	25/9	5	20	5	20
E	A	7	7.5	11	8	4/9	5	13	16	24
F	B, C	9	9	9	9	0	14	23	15	24
G	D	3	3.5	7	4	4/9	20	24	20	24
H	E, F, G	5	5	5	5	0	24	29	24	29

PERT

- Critical Path:
- A - D - G - H = 5+15+4+5 = 29
- A - E – H = 5+8+5 = 18
- Therefore, Project Completion Time = 29 weeks
- Project Variance = 25/9 + 25/9 +4/9 + 0 = 6

PERT

- **Problem 2: A small project consisting of eight activities has the given characteristics:**

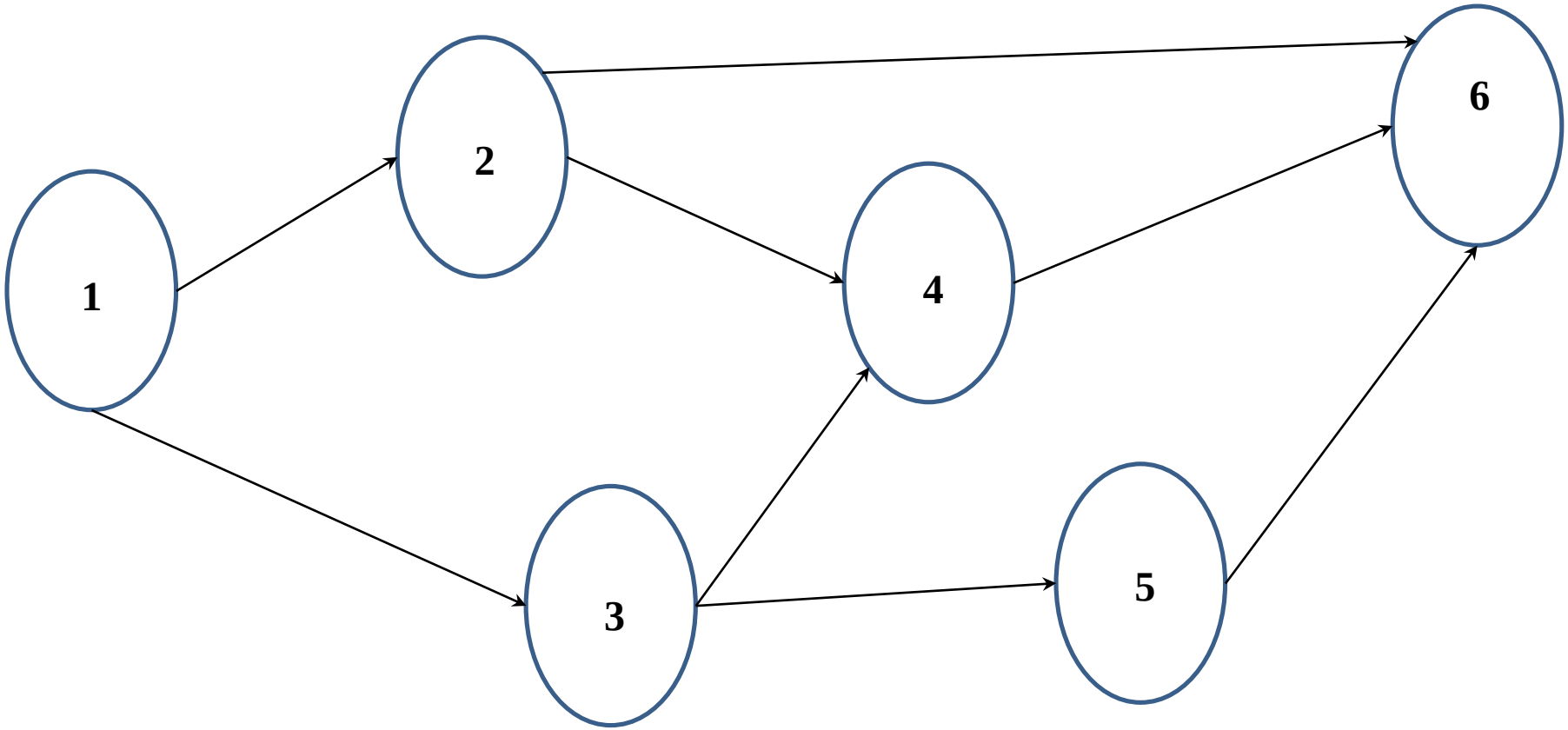
1. Draw the PERT network for the project.
2. Prepare the activity schedule for the project.
3. Determine the critical path.

PERT

Preceding Activity	Activity	Optimistic Time	Most Likely Time	Pessimestic Time
1	2	6	9	12
1	3	3	4	11
2	4	2	5	14
3	4	4	6	8
3	5	1	1.5	5
2	6	5	6	7
4	6	7	8	15
5	6	1	2	3

PERT

1. Draw the PERT network for the project.



PERT

2. Prepare the activity schedule for the project.

Preceding Activity	Activity	Optimistic Time (a)	Most Likely Time (m)	Pessimestic Time (b)	Expected Time $te = \frac{a+4m+b}{6}$	Variance $\sigma^2 t = ((b-a)/6)^2$
1	2	6	9	12		
1	3	3	4	11		
2	4	2	5	14		
3	4	4	6	8		
3	5	1	1.5	5		
2	6	5	6	7		
4	6	7	8	15		
5	6	1	2	3		

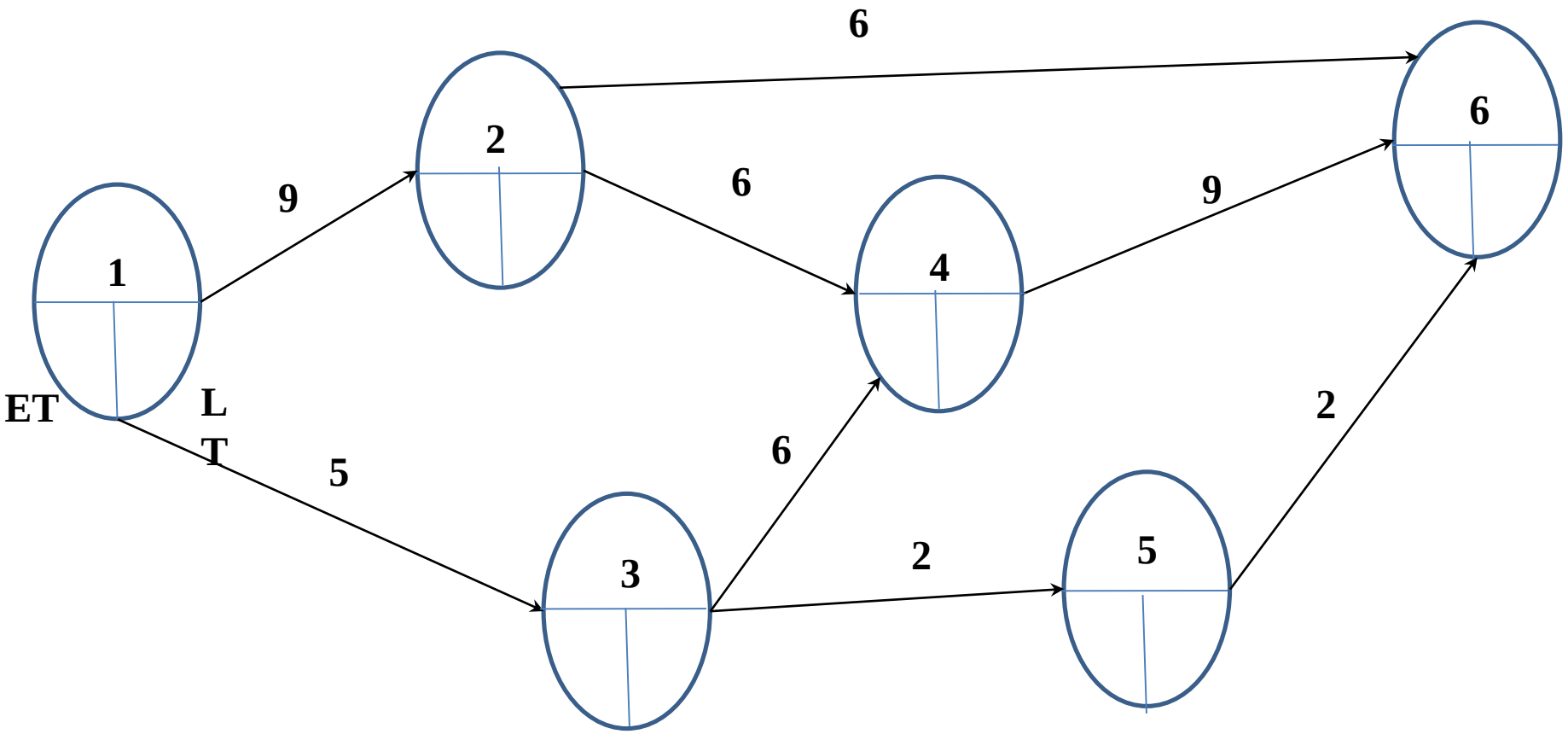
PERT

2. Prepare the activity schedule for the project.

Preceding Activity	Activity	Optimistic Time (a)	Most Likely Time (m)	Pessimestic Time (b)	Expected Time $\overline{te} = \frac{a+4m+b}{6}$	Variance $\sigma^2 t = ((b-a)/6)^2$
1	2	6	9	12	9	1
1	3	3	4	11	5	16/9
2	4	2	5	14	6	4
3	4	4	6	8	6	4/9
3	5	1	1.5	5	2	4/9
2	6	5	6	7	6	1/9
4	6	7	8	15	9	16/9
5	6	1	2	3	2	1/9

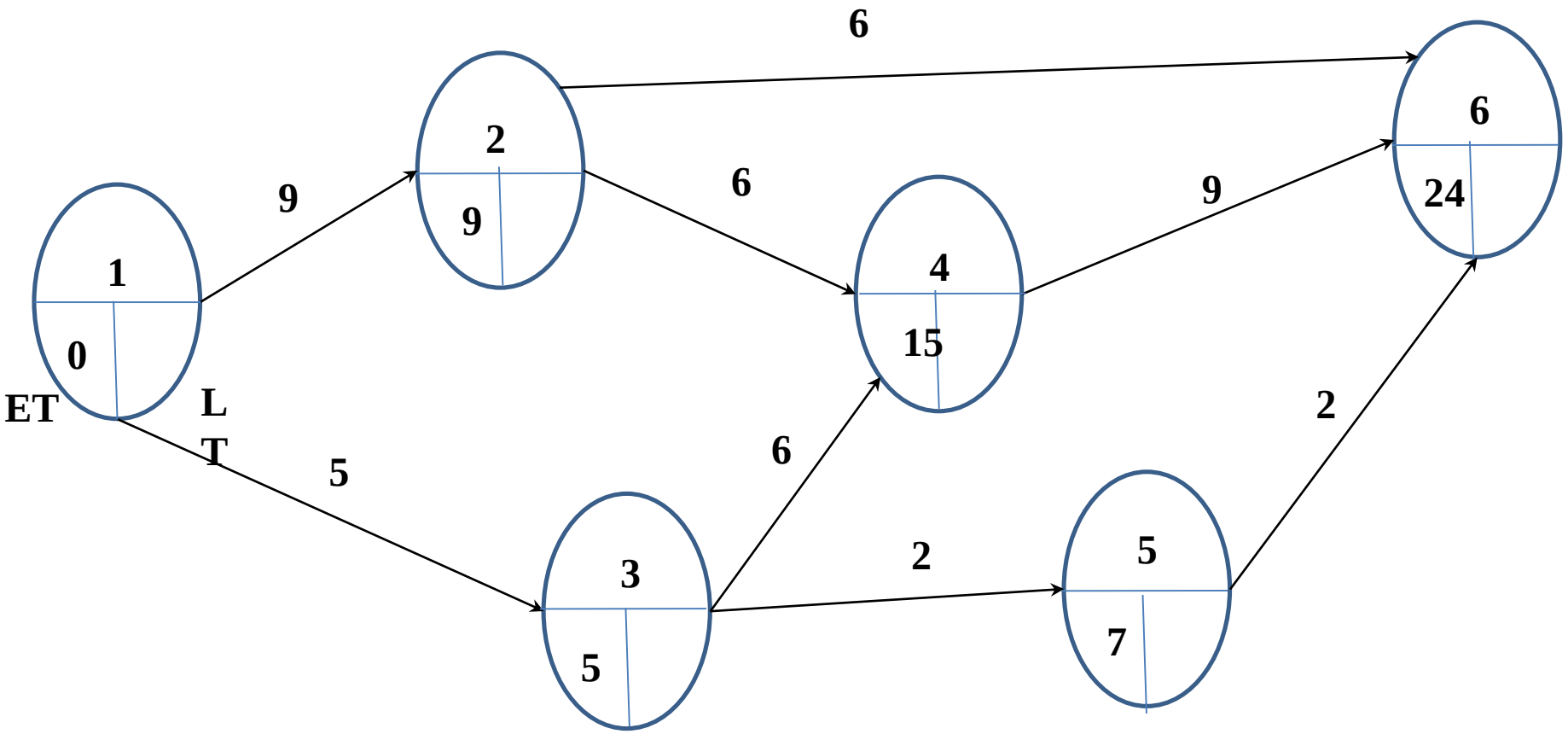
PERT

1. Draw the PERT network for the project.



PERT

1. Draw the PERT network for the project.



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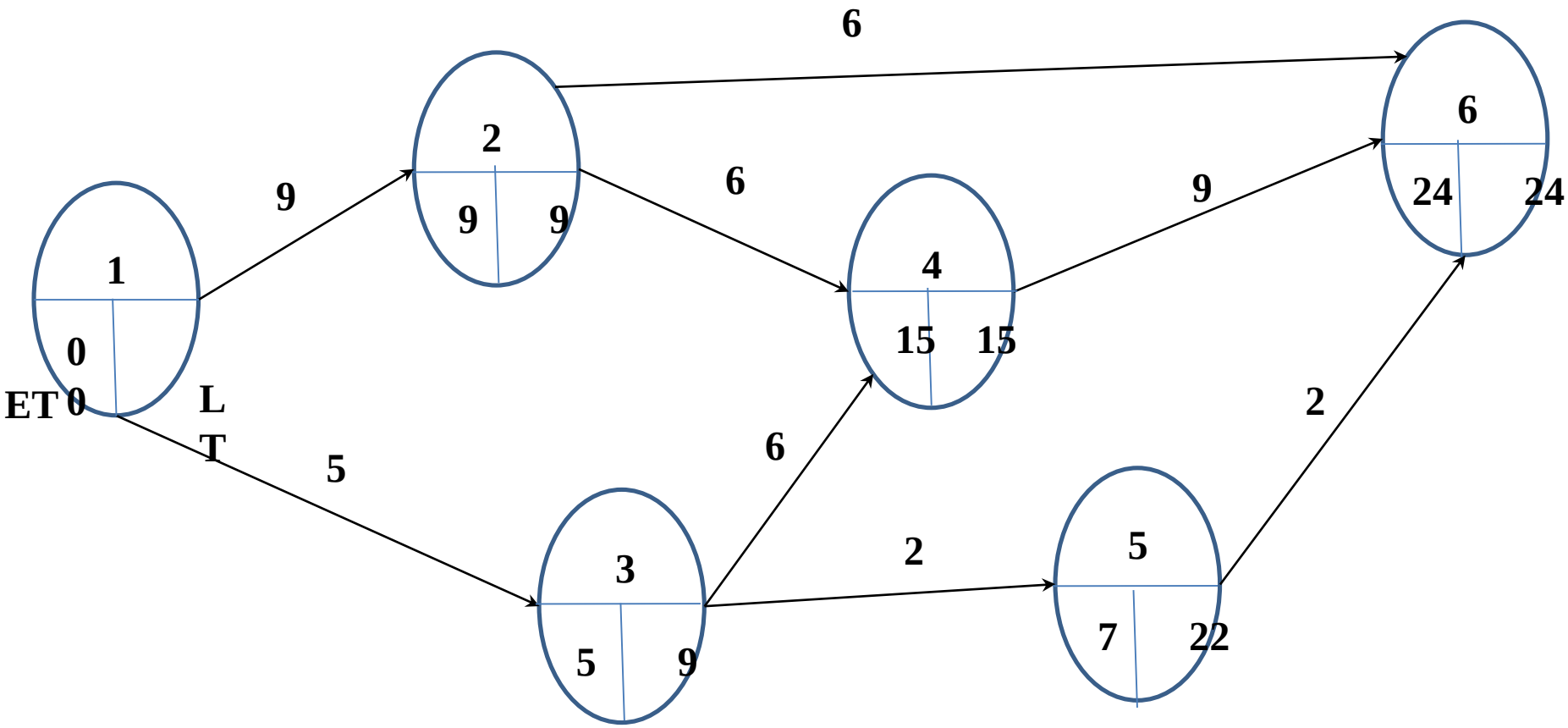
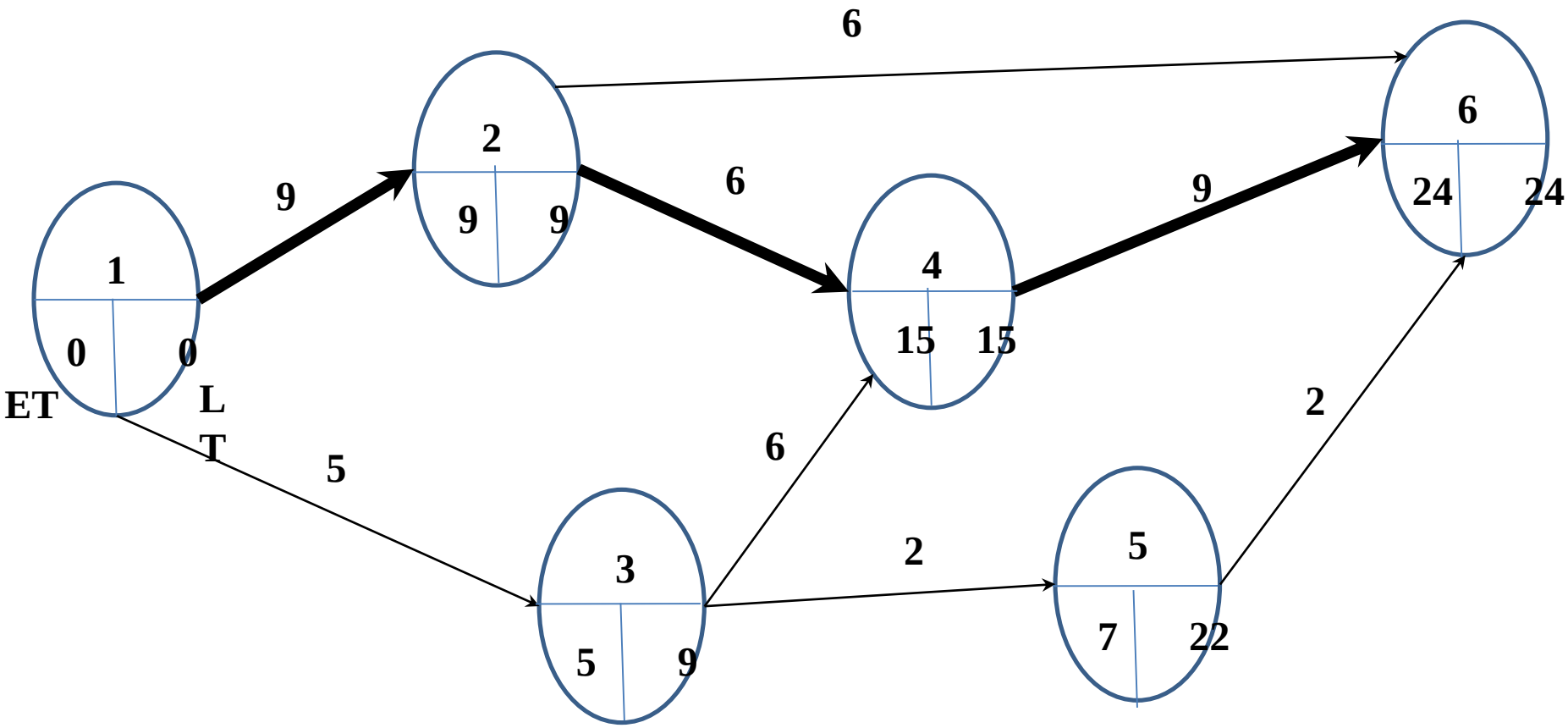


PERT

1. Draw the PERT network for the project.



PERT

- Critical Path:
- 1-2-4-6
- Therefore, Project Completion Time = 24 days
- Project Variance = 1+4+16/9= 6.78

A small project consisting of eight activities has the following characteristics:

Time – Estimates (in weeks)

Activity	Preceding activity	Most optimistic time (a)	Most likely time (m)	Most Pessimestic time (b)
A	None	2	4	12
B	None	10	12	26
C	A	8	9	10
D	A	10	15	20
E	A	7	7.5	11
F	B,C	9	9	9
G	D	3	3.5	7
H	E,F,G	5	5	5

- (i) Draw the PERT network for the project.
- (ii) Prepare the activity schedule for the project.
- (iii) Determine the critical path.

Float

- Project management float is the amount of time a given task can be delayed without causing a delay in the entire project
- **Types of Float**
- The different **types of float** are
- **Total Float** or **Float**
- **Free Float**
- **Project Float**
- **Interfering Float (INTF)**
- **Independent Float (INDF)**

Float Calculation

- **Total float**
- The total amount of time a task can be delayed without affecting the final project delivery date
- To calculate **total float**, subtract the task's earliest finish (EF) date from its latest finish (LF) date. It looks like this: LF - EF = total float

Float Calculation

- **Free float**
- The amount of time a task can be delayed without impacting other tasks in the path
- **Free float**, on the other hand, is calculated by subtracting the task's earliest finish date from its earliest start date. That formula looks like this: ES - EF = free float

- It is the amount of time a **Project can be delayed** without delaying the externally imposed project finish date by the customer, or the project finish date previously committed to by the Project Manager.
- Free & Total Floats are about the time an **activity** can be delayed, while Project float is the amount of time a **Project** can be delayed.

- **<u>Interfering Float (INTF)</u>**
- Interfering Float is the amount of time a schedule activity can be delayed or extended from its early start date without delaying the project finish date.
- If an activity is delayed for the amount of the Free and Interfering Float, then its successor activities are critical.
- **Interfering Float = Total Float – Free Float**

- **Independent Float (INDF)**
- Interfering Float is the maximum amount of time an activity can be delayed without delaying the early start of the succeeding activities and without being affected by the allowable delay of any predecessor activity.
- ***Independent Float Formula***
- **Independent Float (INDF) = Earliest Successors' Early Start – Earliest Predecessors' Late Finish – Activity's duration**

- **Total Float** or **Float = LF -EF**
- **Free Float = ES - EF**
- **Interfering Float (INTF) = Total Float – Free Float**
- **Independent Float (INDF) = Earliest Successors' Early Start – Earliest Predecessors' Late Finish – Activity's duration**

Thank you