UNIT- IV 9L

Inventory Models: Introduction, inventory costs, Economic Order Quantity (EOQ) and Economic Batch Quantity (EBQ) models with and without shortages, inventory models with quantity discounts

Project Management: Introduction, phases of project management, network construction, numbering the events- Fulkerson's rule, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT)

One of the most challenging jobs that any manager can take on is the management of a large-scale project that requires coordinating numerous activities throughout the organization. A myriad of details must be considered in planning how to coordinate all these activities, in developing a realistic schedule, and then in monitoring the progress of the project.

Fortunately, two closely related operations research techniques, PERT (program evaluation and review technique) and CPM (critical path method), are available to assist the project manager in carrying out these responsibilities. These techniques make heavy use of networks (as introduced in the preceding chapter) to help plan and display the coordination of all the activities.

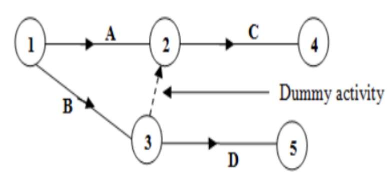
Applications of PERT and CPM.

1. Construction of a new plant
2. Research and development of a new product
3. NASA space exploration projects
4. Movie productions
5. Building a ship
6. Government-sponsored projects for developing a new weapons system
7. Relocation of a major facility
8. Maintenance of a nuclear reactor
9. Installation of a management information system
10. Conducting an advertising campaign

Network Diagram Representation:

In a network representation of a project certain definitions are used

1. Activity



Any individual operation which utilizes resources and has an end and a beginning is called activity. An arrow is commonly used to represent an activity with its head indicating the direction of progress in the project. These are classified into four categories

1. Predecessor activity – Activities that must be completed immediately prior to the start of another activity are called predecessor activities.

2. Successor activity – Activities that cannot be started until one or more of other activities are completed but immediately succeed them are called successor activities.

3. Concurrent activity – Activities which can be accomplished concurrently are known as concurrent activities. It may be noted that an activity can be a predecessor or a successor to an event or it may be concurrent with one or more of other activities.

4. Dummy activity – An activity which does not consume any kind of resource but merely depicts the technological dependence is called a dummy activity.

The dummy activity is inserted in the network to clarify the activity pattern in the following two situations

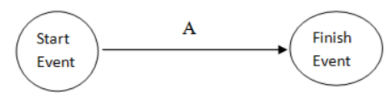
→ To make activities with common starting and finishing points distinguishable

→ To identify and maintain the proper precedence relationship between activities that is not connected by events.

For example, consider a situation where A and B are concurrent activities. C is dependent on A and D is dependent on A and B both. Such a situation can be handled by using a dummy activity as shown in the figure.

2. Event

An event represents a point in time signifying the completion of some activities and the beginning of new ones. This is usually represented by a circle in a network which is also called a node or connector.

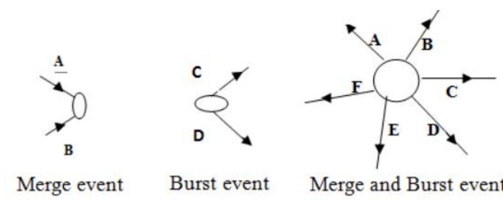


The events are classified in to three categories

1. Merge event – When more than one activity comes and joins an event such an event is known as merge event.

2. Burst event – When more than one activity leaves an event such an event is known as burst event.

3. Merge and Burst event – An activity may be merge and burst event at the same time as with respect to some activities it can be a merge event and with respect to some other activities it may be a burst event.



Difference between event and activity

An event is that particular instant of time at which some specific part of project is to be achieved while an activity is the actual performance of a task. An activity requires time and resources for its completion. Events are generally described by such words as complete, start, issue, approves, taste etc. while the word like design, process, test, develop, prepare etc. shows that a work is being accomplished and thus represent activity. While drawing networks, it is assumed that

a) The movement is from left to right and

b) Head event has a number higher than the tail event.

Thus, the activity (i-j) always means that job which begins at event (i) is completed at event (j).

Network representation is based on the following two axioms.

a) An event is not said to be complete until all the activities flowing into it are completed.

b) No subsequent activities can begin until its tail event is reached or completed.

3. Sequencing

The initial step in project scheduling process is the determination of all specific activities that comprise the project and their interdependence relationships. In order to make a network following points should be taken into consideration.

→ What job or jobs precede it?

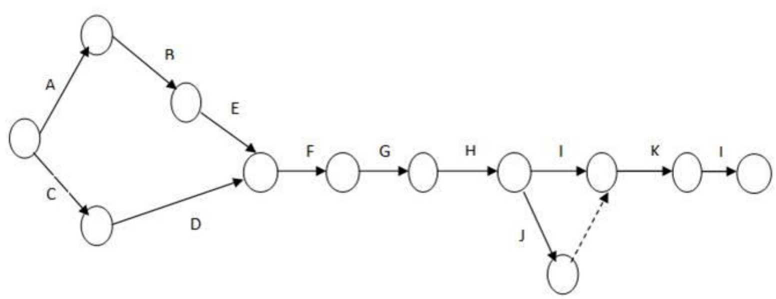
→ What job or jobs run concurrently?
→ What job or jobs follow it?
→ What controls the start and finish of a job?

Since all further calculations are based on the network, it is necessary that a network be drawn with full care. There are many ways to draw a network, in this lesson we will describe the method which follows the precedence table.

The following example of preparation of Paneer (Cottage cheese) shows the basic steps required in drawing a network.

Activity	Description	Preceding Activity
A	Receive whole cow/buffalo milk	-
B	Standardize milk to obtain desired level of fat percentage	A
C	Take citric acid and prepare 1% solution	-
D	Heat the citric acid to $70\,^{\circ}C$	C
E	Bring the standardized milk to boil on medium heat	B
F	Cool the milk to $70\,^{\circ}C$ and add slowly the solution of citric acid till yellowish whey separates.	D, E
G	Strain the mixture through a clean muslin cloth.	F
H	Hold it under running water for a minute and press out the excess water.	G
I	Hang the muslin for 15-20 minutes and drain out all the whey.	H
J	Prepare mould to form Paneer block	H
K	Fill the mass into the block and tie the muslin	J
L	Place it under something heavy for up to two hours.	K
M	Cut the paneer into chunks and use as required.	L

In the above table due consideration has been given to proceedings of an activity. While drawing the network, other factors will be considered. The activity A has no preceding activity, and it is represented by an arrow line (Fig.). Likewise, activity C has no preceding activity and both activities A and C can be done simultaneously so they are shown as concurrent activities. Activities B and D are preceded by the activities A and C respectively. The complete network is shown in Fig.



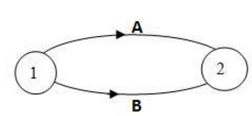
Guidelines for Drawing Network Diagram

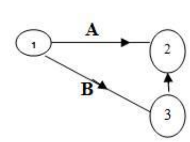
There are number of rules in connection with the handling of events and activities of a project network which are given below:

a) No single activity can be represented twice in the network. This is to be distinguished from the case where one activity is broken into segments. In such a case each segment may be represented by a separate arrow.

b) No two activities can be identified by the same beginning and end event. In such cases, a dummy activity is introduced to resolve the problem as shown in Fig.

c) In order to ensure the correct precedence relationship in arrow diagram following question must be checked whenever any activity is added to a network.





d) What activity must be completed immediately before this activity can start?

e) What activities must follow this activity?

f) What activities must occur simultaneously with this activity?

g) Thus, a network should be developed on the basis of logical or technical dependence.

h) The arrows depicting various activities are indicative of logical precedence only; hence length and bearing of the arrows are of no significance.

i) The flow of the diagram should be from left to right.

j) Two events are numbered in such a way that the event of higher number can happen only after the event of lower number is completed.

k) Arrows should be kept straight and not curved. Avoid arrow which cross each other.

l) Avoid mixing two directions vertical and standing arrows may be used if necessary.

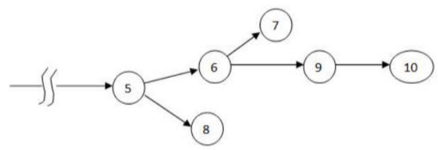
m) Use dummy activity freely in rough graph but final network should have only reluctant dummy.

n) The network has only one entry point called the start event and one point of emergence called end event.

o) Angle between the arrows should be as large as possible.

Error in Drawing Network

There are three types of errors which are common in network diagrams

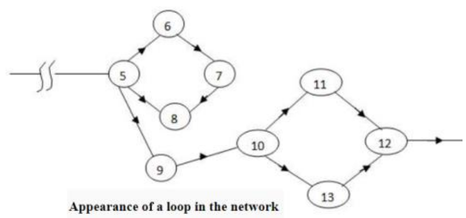


Dangling error

1 Dangling error:

To disconnect an activity before the completion of all activities in a network diagram is known as dangling.

In Fig. the activity 5 to 8, 6 to 7 are known as dangling error. These are not last activities in the network.



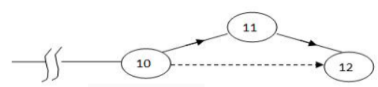
Appearance of a loop in the network

2 Looping error

Looping error is also known as cyclic error in the network. Drawing an endless loop in a network diagram is known as error of looping as shown in Fig.

3 Reductancy error

Unnecessarily inserting the dummy activity in a network diagram is known as error of reductancy as shown in Fig., in which putting an dummy activity from 10 to 12 is a reductancy error.



Reductancy error

Labelling of a Network Diagram

For network representation it is necessary that various nodes be properly labelled. For convenience, labelling is done on a network diagram. A standard procedure called i-j rule developed by D.R.F Fulkerson is most commonly used for this purpose.

Fulkerson's i-j Rule

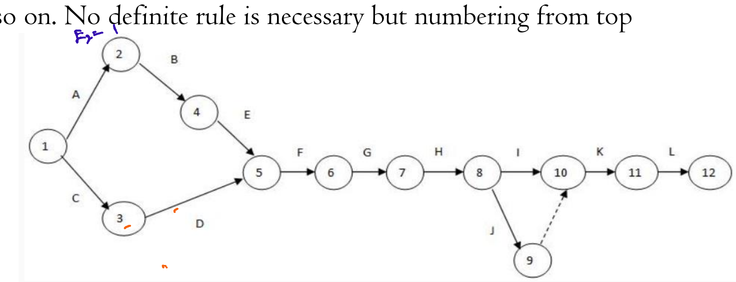
Step 1: First, a start event is one which has arrows emerging from it but not entering it. Find the start event and label it as number1.

Step 2: Delete all arrows emerging from all numbered events. This will create at least one new start event out of the preceding events.

Step 3: Number all new start events �2�, �3� and so on. No definite rule is necessary but numbering from top to bottom may facilitate other users using the network when there are more than one new start event.

Step 4: Go on repeating step no. 2 & 3 until the end reached.

These rules are illustrated by taking into consideration the previous Example and network diagram as shown in Fig.



Example:

Draw the network diagram for the following project and find the critical path and maximum time for completion of the project.

Activity	A	B	C	D	E	F	G	H	I	J	K	L
Preceded by	-	A	A	B	B	C	C	F	D	G, H	E	I
Duration (weeks)	10	9	7	6	12	6	8	8	4	11	5	7

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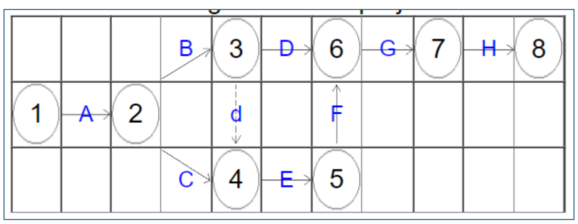
1. An assembly is to be made from two parts X and Y. Both parts must be turned on a lathe Y must be polished where as X need not be polished. The sequence of activities, together with their predecessors, is given below

Activity	Description	Predecessor Activity
A	Open work order	-
B	Get material for X	A
C	Get material for Y	A
D	Turn X on lathe	B
E	Turn Y on lathe	B,C
F	Polish Y	E
G	Assemble X and Y	D,F
H	Pack	G

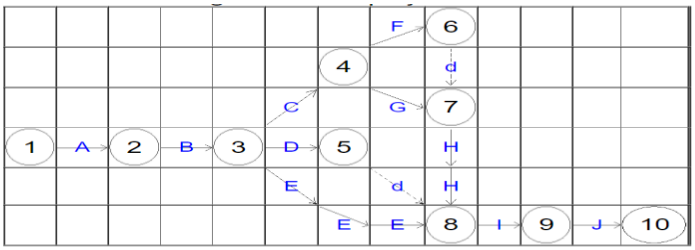
Draw a network diagram of activities for the project.



2. Listed in the table are the activities and sequencing necessary for a maintenance job on heat exchangers in a refinery

Activity	Description	Predecessor Activity
A	Dismantle pipe connections	-
B	Dismantle heater, closure and floating front	A
C	Remove tube bundle	B
D	Clean bolts	B
E	Clean heater and floating head front	B
F	Clean tube bundle	C
G	Clean shell	C
H	Replace tube bundle	F,G
I	Prepare shell pressure test	D,E,H
J	Prepare tube pressure test and reassemble	I

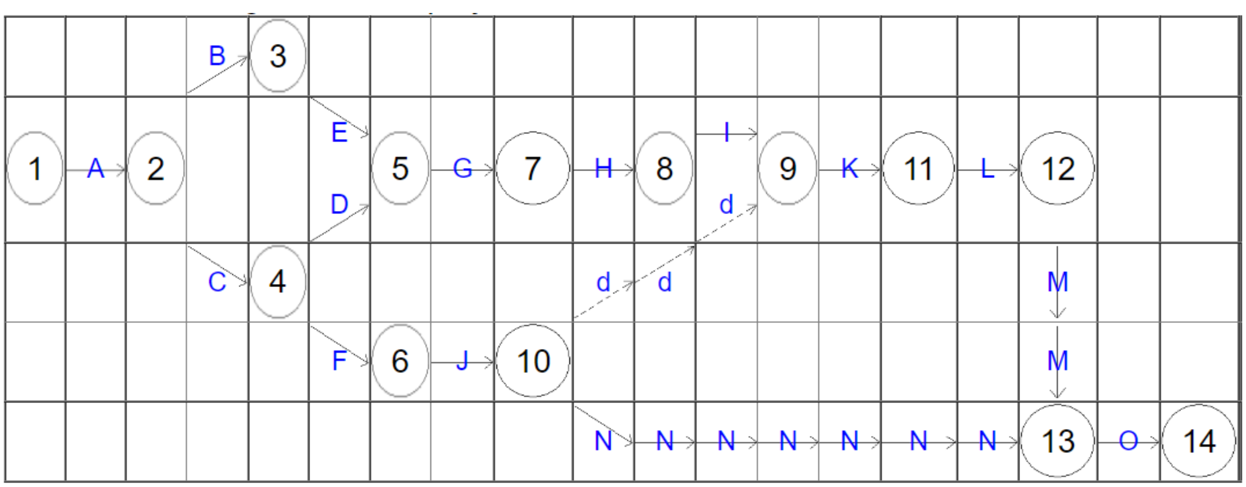
Draw a network diagram of activities for the project.



3. Listed in the table are the activities and sequencing necessary for the completion of a recruitment procedure for management trainees in a firm.

Activity	Description	Predecessor Activity
A		-
B		A
C		A
D		C
E		B
F		C
G		D,E
H		G
I		H
J		F
K		I,J
L		K
M		L
N		J
O		M,N

Draw a network diagram of activities for the project.



4. An established company has decided to add a new product to its line. It will buy the product from a manufacturing concern, package it, and sell it to a number of distributors that have been selected on a geographical basis. Market research has already indicated the volume expected and the size of sales force required. The steps shown in the following table are to be planned.

Activity	Description	Predecessor Activity	Duration (days)
A	Organize sales office	-	6
B	Hire salesman	A	4
C	Train salesman	B	7
D	Select advertising agency	A	2
E	Plan advertising campaign	D	4
F	Conduct advertising campaign	E	10
G	Design package	-	2
H	Setup packaging campaign	G	10
I	Package initial stocks	J,H	6
J	Order stock from manufacturer	-	13
K	Select distributors	A	9
L	Sell to distributors	C,K	3
M	Ship stocks to distributors	I,L	5

(a) Draw an arrow diagram for the project.
(b) Indicate the criticla path.
(c) For each non-critical activity, find the total and free float.

5. An established company has decided to add a new product to its line. It will buy the product from a manufacturing concern, package it, and sell it to a number of distributors that have been selected on a geographical basis. Market research has already indicated the volume expected and the size of sales force required. The steps shown in the following table are to be planned.

Activity	Description	Predecessor Activity	Duration (days)
A		-	14
B		A	4
C		B	2
D		C	1
E		A	2
F		E	3
G		E	2
H		E	4
I		H,L	3
J		K	12

K		D,F,G	4
L		J	2
M		H,L	2

(a) Draw an arrow diagram for the project.
(b) Indicate the critical path.
(c) For each non-critical activity, find the total and free float.

Advantages - PERT/CPM

→ A PERT/CPM chart explicitly defines and makes visible dependencies (precedence relationships) between the elements,

→ PERT/CPM facilitates identification of the critical path and makes this visible,

→ PERT/CPM facilitates identification of early start, late start, and slack for each activity,

→ PERT/CPM provides for potentially reduced project duration due to better understanding of dependencies leading to improved overlapping of activities and tasks where feasible.

Disadvantages -PERT/CPM:

→ There can be potentially hundreds or thousands of activities and individual dependency relationships,

→ The network charts tend to be large and unwieldy requiring several pages to print and requiring special size paper,

→ The lack of a timeframe on most PERT/CPM charts makes it harder to show status although colours can help (e.g., specific colour for completed nodes),

→ When the PERT/CPM charts become unwieldy, they are no longer used to manage the project.

Critical Path in Network Analysis:

The notations used are

(i, j) = Activity with tail event i and head event j

Ei = Earliest occurrence time of event i

Lj = Latest allowable occurrence time of event j

Dij = Estimated completion time of activity (i, j)

(Es)ij = Earliest starting time of activity (i, j)

(Ef)ij = Earliest finishing time of activity (i, j)

(Ls)ij = Latest starting time of activity (i, j)

(Lf)ij = Latest finishing time of activity (i, j)

The procedure is as follows

1. Determination of Earliest time (Ej): Forward Pass computation

→ Step 1

The computation begins from the start node and move towards the end node. For easiness, the forward pass computation starts by assuming the earliest occurrence time of zero for the initial project event.

→ Step 2

i. Earliest starting time of activity (i, j) is the earliest event time of the tail end event i.e. (Es)ij = Ei

ii. Earliest finish time of activity (i, j) is the earliest starting time + the activity time i.e. (Ef)ij = (Es)ij + Dij or (Ef)ij = Ei + Dij

iii. Earliest event time for event j is the maximum of the earliest finish times of all activities ending in to that event i.e. Ej = max [(Ef)ij for all immediate predecessor of (i, j)] or Ej =max [Ei + Dij]

2. Backward Pass computation (for latest allowable time)

→ **Step 1**

For ending event assume E = L. Remember that all E's have been computed by forward pass computations.

→ **Step 2**

Latest finish time for activity (i, j) is equal to the latest event time of event j i.e. (Lf)ij = Lj

→ **Step 3**

Latest starting time of activity (i, j) = the latest completion time of (i, j) – the activity time or (Ls)ij =(Lf)ij - Dij or (Ls)ij = Lj - Dij

→ **Step 4**

Latest event time for event 'i' is the minimum of the latest start time of all activities originating from that event i.e. Li = min [(Ls)ij for all immediate successor of (i, j)] = min [(Lf)ij - Dij] = min [Lj - Dij]

3. Determination of floats and slack times

There are three kinds of floats

→ Total float – The amount of time by which the completion of an activity could be delayed beyond the earliest expected completion time without affecting the overall project duration time.

Mathematically

(Tf)ij = (Latest start – Earliest start) for activity (i – j)

(Tf)ij = (Ls)ij - (Es)ij or (Tf)ij = (Lj - Dij) – Ei

→ Free float – The time by which the completion of an activity can be delayed beyond the earliest finish time without affecting the earliest start of a subsequent activity.

Mathematically

(Ff)ij = (Earliest time for event j – Earliest time for event i) – Activity time for (i,j)

(Ff)ij = (Ej - Ei) - Dij

→ Independent float – The amount of time by which the start of an activity can be delayed without effecting the earliest start time of any immediately following activities, assuming that the preceding activity has finished at its latest finish time.

Mathematically

(If)ij = (Ej - Li) - Dij

The negative independent float is always taken as zero.

→ Event slack - It is defined as the difference between the latest event and earliest event times.

Mathematically

Head event slack = Lj – Ej

Tail event slack = Li – Ei

4. Determination of critical path

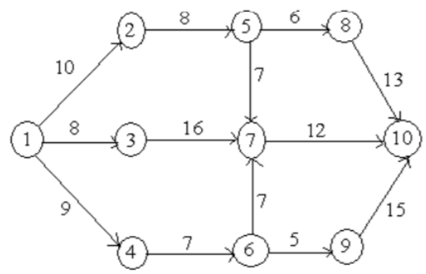
→ Critical event – The events with zero slack times are called critical events. In other words the event i is said to be critical if Ei = Li

→ Critical activity – The activities with zero total float are known as critical activities. In other words an activity is said to be critical if a delay in its start will cause a further delay in the completion date of the entire project.

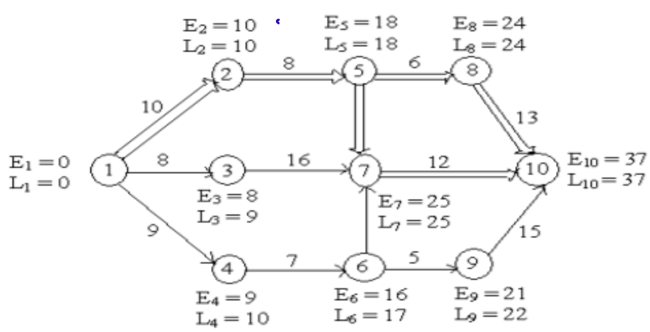
→ Critical path – The sequence of critical activities in a network is called critical path. The critical path is the longest path in the network from the starting event to ending event and defines the minimum time required to complete the project.

Example I

Determine the early start and late start in respect of all node points and identify critical path for the following network.



Ans:



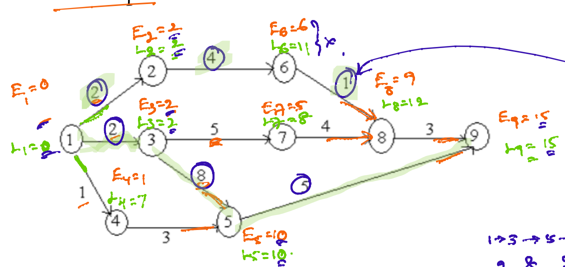
Activity(i, j)	Normal Time (D_{ij})	Earliest Time		Latest Time		Float Time (L_i - D_{ij}) - E_i
		Start (E_i)	Finish ($E_i + D_{ij}$)	Start (L_i - D_{ij})	Finish (L_i)	
(1, 2)	10	0	10	0	10	0
(1, 3)	8	0	8	1	9	1
(1, 4)	9	0	9	1	10	1
(2, 5)	8	10	18	10	18	0
(4, 6)	7	9	16	10	17	1
(3, 7)	16	8	24	9	25	1
(5, 7)	7	18	25	18	25	0
(6, 7)	7	16	23	18	25	2
(5, 8)	6	18	24	18	24	0
(6, 9)	5	16	21	17	22	1
(7, 10)	12	25	37	25	37	0
(8, 10)	13	24	37	24	37	0
(9, 10)	15	21	36	22	37	1

From the table, the critical nodes are (1, 2), (2, 5), (5, 7), (5, 8), (7, 10) and (8, 10)
From the table, there are two possible critical paths
i. 1 → 2 → 5 → 8 → 10
ii. 1 → 2 → 5 → 7 → 10

Forward pass = E_s, E_F Start Node $E_s = 0$.
Backward pass = L_s L_F End Node $E_F = L_F$.
Neetwork

Example 2 Find the critical path and calculate the slack time for the following network

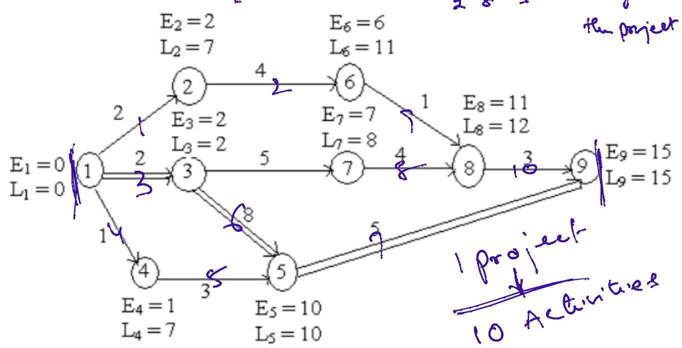
$E_2 = E_1 + D_1$
$E_5 = [E_4 + 3 = 4, E_3 + 8 = 10]$
$L_8 = L_9 - D_{ij}$
$L_1 = \min[L_2 - 2, L_3 - 2, L_4 - 1]$



t_o, t_m, t_p
$\frac{(t_o + 4t_m + t_p)}{6}$
variance

1→3→5→9.
2 8 5 = 15 days to complete the project

Ans: $\boxed{E-L=0}$ critical path



1 project → 10 Activities

Duration – complete project
CPM – Exact days.
probability of completion.
PERT = Probability to complete the activities and inform % of assurance to complete the project

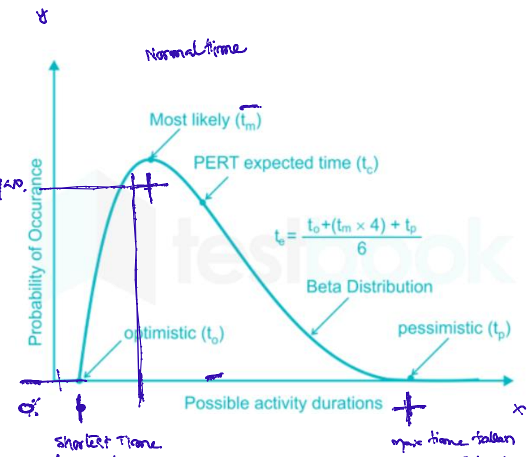
The earliest time and the latest time are obtained below

Activity(i, j)	Normal Time (D_{ij})	Earliest Time		Latest Time		Float Time $(L_i - D_{ij}) - E_i$
		Start (E_i)	Finish ($E_i + D_{ij}$)	Start ($L_i - D_{ij}$)	Finish (L_i)	
(1, 2)	2	0	2	5	7	5
(1, 3)	2	0	2	0	2	0
(1, 4)	1	0	1	6	7	6
(2, 6)	4	2	6	7	11	5
(3, 7)	5	2	7	3	8	1
(3, 5)	8	2	10	2	10	0
(4, 5)	3	1	4	7	10	6
(5, 9)	5	10	15	10	15	0
(6, 8)	1	6	7	11	12	5
(7, 8)	4	7	11	8	12	1
(8, 9)	3	11	14	12	15	1

From the above table, the critical nodes are the activities (1, 3), (3, 5) and (5, 9)
The critical path is $1 \rightarrow 3 \rightarrow 5 \rightarrow 9$

Project Evaluation and Review Technique (PERT):

https://studylib.net/doc/8544685/project-control-with-pert-cpm



The main objective in the analysis through PERT is to find out the completion for a particular event within specified date. The PERT approach takes into account the uncertainties. The three time values are associated with each activity

1. Optimistic time – It is the shortest possible time in which the activity can be finished. It assumes that everything goes very well. This is denoted by t_o.

may occur

2. Most likely time – It is the estimate of the normal time the activity would take. This assumes normal delays. If a graph is plotted in the time of completion and the frequency of completion in that time period, then most likely time will represent the highest frequency of occurrence. This is denoted by t_m.

3. Pessimistic time – It represents the longest time the activity could take if everything goes wrong. As in optimistic estimate, this value may be such that only one in hundred or one in twenty will take time longer than this value. This is denoted by t_p.

In PERT calculation, all values are used to obtain the percent expected value.

1. Expected time – It is the average time an activity will take if it were to be repeated on large number of times and is based on the assumption that the activity time follows Beta distribution, this is given by $t_e = (t_o + 4\,t_m + t_p) / 6$

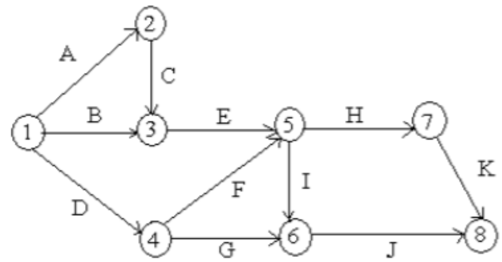
2. The variance for the activity is given by $\sigma^2 = [(tp - to) / 6]^2$

The variance is a measure of variability. It is calculated by taking the average of squared deviations from the mean. Variance tells you the degree of spread in your data set. The more spread the data, the larger the variance is in relation to the mean.

Example I

For the project Find the earliest and latest expected time to each event and also critical path in the network.

Task:	A	B	C	D	E	F	G	H	I	J	K
Least time:	4	5	8	2	4	6	8	5	3	5	6
Greatest time:	8	10	12	7	10	15	16	9	7	11	13
Most likely time:	5	7	11	3	7	9	12	6	5	8	9

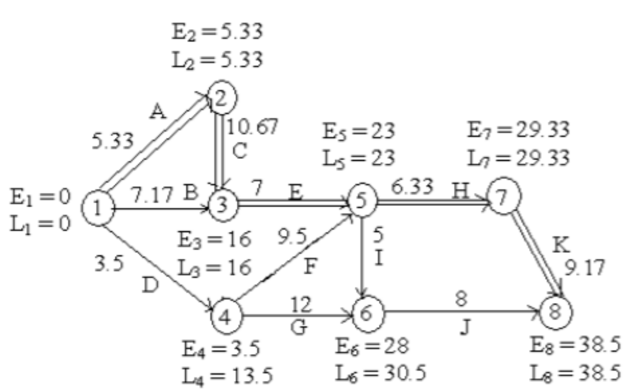


Ans:

Task	Least time(t_0)	Greatest time (t_p)	Most likely time (t_m)	Expected time $(to + t_p + 4t_m)/6$
A	4	8	5	5.33
B	5	10	7	7.17
C	8	12	11	10.67
D	2	7	3	3.5
E	4	10	7	7
F	6	15	9	9.5
G	8	16	12	12
H	5	9	6	6.33
I	3	7	5	5
J	5	11	8	8
K	6	13	9	9.17

Task	Expected time (t_e)	Start		Finish		Total float
		Earliest	Latest	Earliest	Latest	
A	5.33	0	0	5.33	5.33	0
B	7.17	0	8.83	7.17	16	8.83
C	10.67	5.33	5.33	16	16	0
D	3.5	0	10	3.5	13.5	10
E	7	16	16	23	23	0
F	9.5	3.5	13.5	13	23	10
G	12	3.5	18.5	15.5	30.5	15
H	6.33	23	23	29.33	29.33	0
I	5	23	25.5	28	30.5	2.5
J	8	28	30.5	36	38.5	2.5
K	9.17	29.33	29.33	31.5	38.5	0

The critical path is A →C →E → H → K



	t_o	t_m	t_p	t_e	σ	σ^2
A	4	8	5	1.50	0.17	0.03
B	5	10	7	2.00	0.33	0.11
C	8	12	11	3.17	0.50	0.25
D	2	7	3	0.83	0.17	0.03
E	4	10	7	1.83	0.50	0.25
F	6	15	9	2.50	0.50	0.25
G	8	16	12	3.33	0.67	0.44
H	5	9	6	1.83	0.17	0.03
I	3	7	5	1.33	0.33	0.11
J	5	11	8	2.17	0.50	0.25
K	6	13	9	2.5	0.50	0.25

Example: A project has the following characteristics. Construct a PERT network.

(i) Find the critical path and variance for each event.

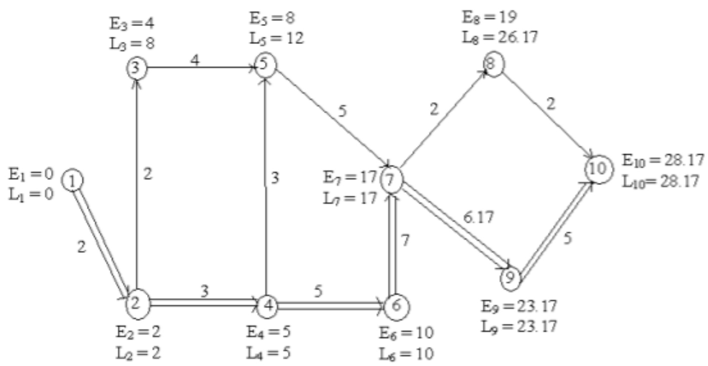
(ii)Find the probability that all Critical Acitivities will be completed in

Activity	Most optimistic time (a)	Most pessimistic time (b)	Most likely time (m)
(1 – 2)	1	5	1.5
(2 – 3)	1	3	2
(2 – 4)	1	5	3
(3 – 5)	3	5	4
(4 – 5)	2	4	3
(4 – 6)	3	7	5
(5 – 7)	4	6	5
(6 – 7)	6	8	7
(7 – 8)	2	6	4
(7 – 9)	5	8	6
(8 – 10)	1	3	2
(9 – 10)	3	7	5

Ans:

Activity	(a)	(b)	(m)	(4m)	t_e $(a + b + 4m)/6$	v $[(b - a) / 6]^2$
(1 – 2)	1	5	1.5	6	2	4/9
(2 – 3)	1	3	2	8	2	1/9
(2 – 4)	1	5	3	12	3	4/9
(3 – 5)	3	5	4	16	4	1/9
(4 – 5)	2	4	3	12	3	1/9
(4 – 6)	3	7	5	20	5	4/9
(5 – 7)	4	6	5	20	5	1/9
(6 – 7)	6	8	7	28	7	1/9
(7 – 8)	2	6	4	16	4	4/9
(7 – 9)	5	8	6	24	6.17	1/4
(8 – 10)	1	3	2	8	2	1/9
(9 – 10)	3	7	5	20	5	4/9

The network is constructed as shown below



The Critical path = 1 → 2 → 4 → 6 → 7 →9 →10

	PERT	CPM
1.	It is probabilistic model with uncertainty in activity duration. The duration of each activity is normally computed from multiple time estimates.	A deterministic model with well known activity (single) time based upon the past experience. It does not deal with uncertainty with time.
2.	PERT is said to be an event oriented as the result of analysis are expressed in terms of events.	It is an activity oriented as its results are calculated on the basis of activities.
3.	It uses dummy activities to represent project sequencing of the activities.	It does not make use of dummy activities to represent the project sequencing.
4.	PERT is usually used for those projects where time required to complete various activities is not known a priori.	This is commonly used for those projects which are repetitive in nature and here one has prior experience of handling similar projects.
5.	PERT is generally applied for planning and scheduling research program and developing projects.	CPM is generally used for construction and business problems.
6.	PERT analysis usually does not consider cost.	CPM deals with the cost of project schedules and their minimization.

7.	PERT is an important control device as it assists the management in controlling a project by constant review of such delays in the activities.	It is difficult to use CPM as controlling device because it requires repetition of the entire evaluation of project each time the changes are introduced in the network.
8.	PERT helps the manager to schedule and coordinate various activities so that project can be completed on scheduled time.	CPM plans dual emphasis on time cost and evaluates the trade-off between project cost and time.
9.	It makes use of the statistical devices in the determination of time estimates.	It does not make use of the statistical devices in the determination of time estimates