22/11/2021
Monday

Module 4

Introduction

Network scheduling is a technique used for the planning and scheduling last project in the field of construction, maintainance, research and develop ments and etc...

Technique is a method of minimizing troublespots such as production delay and interuption by determining critical factors and coordinating various parts of overall jobs. There are two basic planning and control technique that utilize a network to complete ~~an~~ a predeterminant project of schedule. These are

1. Critical path method (CPM)
2. Program Evaluation & Review technique (PERT)

Network: Basic components

A network is a graphic representation of a project operation and is composed of activities and events that must be completed to reach the end objective of the project, showing the planning sequence of their accomplishment, their dependence and inter relationship.

The basic components of a network are

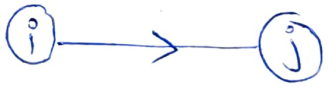
1) Activity

An activity is a task or an item of work to be done that consumes time, effort, money or other resources. It lies between two events called the preceeding and succeeding event. An activity is represented by an arrow with its head indicating the sequence in each the events are to occur.

2) Event

An event represent the start (beginning) or completion (end) of some activity and as such it consumes

no-time. It has no time duration and does not consume any resources. An event is nothing but a node and is generally represented on the network by a circle, rectangle, hexagon or some other geometric shape. An event is not complete until all the activites following into it are completed. Activities are identified by the numbe of starting and ending event. An arrow (i, j) extended between two events the ~~tail~~ head event i represented the start of an activity and tail event j represent the completion of an activity as shown below,



An event representing the joint completion of more than one activity is called merge event. If an event represent the join initiation of more than one activity it is called burst event.

The activites can be further classified into following 3 categories,

1. Predecessor activity

- An activity which must be completed before one or more other activity start is known as predecessor activity

2. Successor activity

- An activity which start immediately after one or more other activities are completed are known as successor activity.

3. Dummy activity.

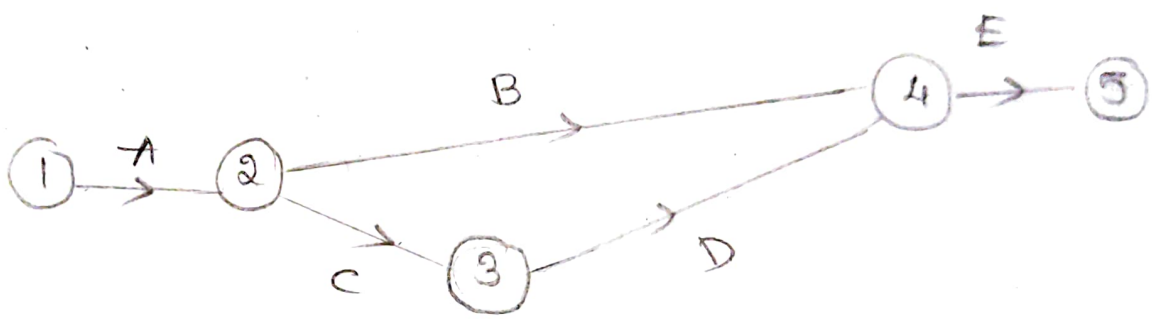
- An activity which doesn't consume either any resources and time is known as dummy activity
A dummy activity is depicted by dotted lines. in the network diagram

(1) · Draw the follow network diagram for the following activities

1)

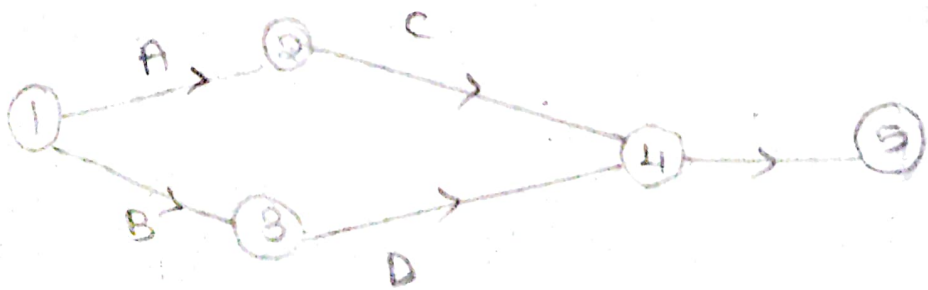
Activity	Preceeding Activity
A	-
B	A
C	A
D	C
E	B, D

ans:



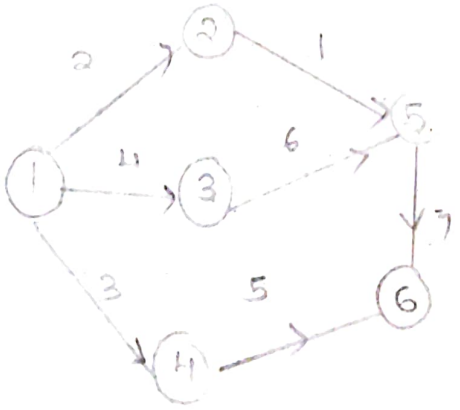
2)

Activity	Proceeding Activity
A	-
B	-
C	A
D	B
E	C, D



Solution
Monday (8) Draw the network diagram with following network activities.

Activity (i, j)	Time duration
1 - 2	2
1 - 3	4
1 - 4	3
2 - 5	1
3 - 5	6
4 - 6	5
5 - 6	7.



Dummy Activity

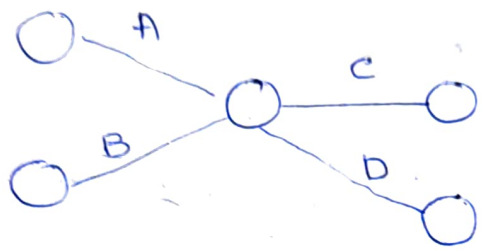
- A dummy activity in the network is added only to represent the given precedence relation among activity of project. When

a) 2 or more parallel activities in a project

has same head and tail event.

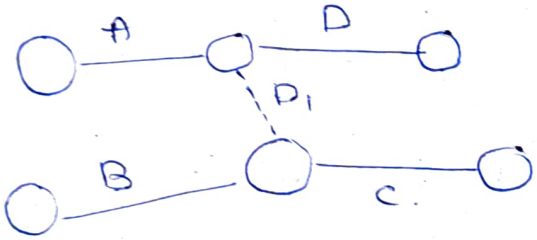
b) 2 or more activities have some but not all of their immediate predecessor activity in common.

Eg:

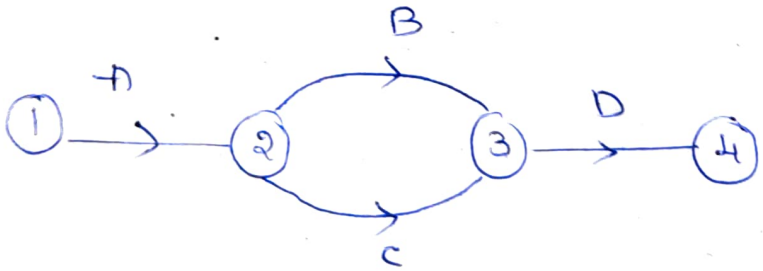


The predecessor of C ... A and B
we want predecessor of D as A only
D → A

Introducing dummy.

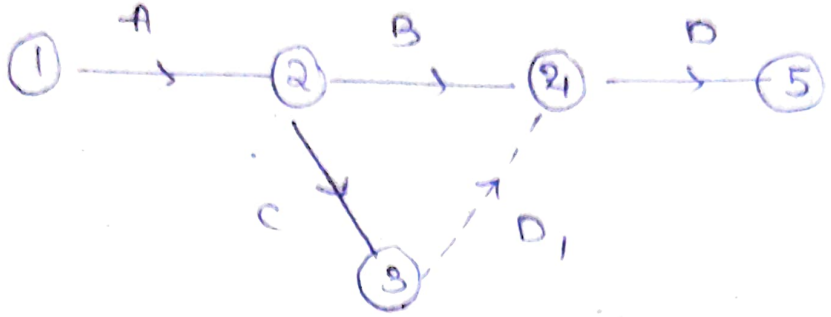


Two or more activities can be performed concurrently as shown in the figure.



Here two activities namely B and C have the same end nodes in such cases a special form of constraint is introduced this is called dummy activity

The modified representation of above network using dummy activity is shown in the figure.

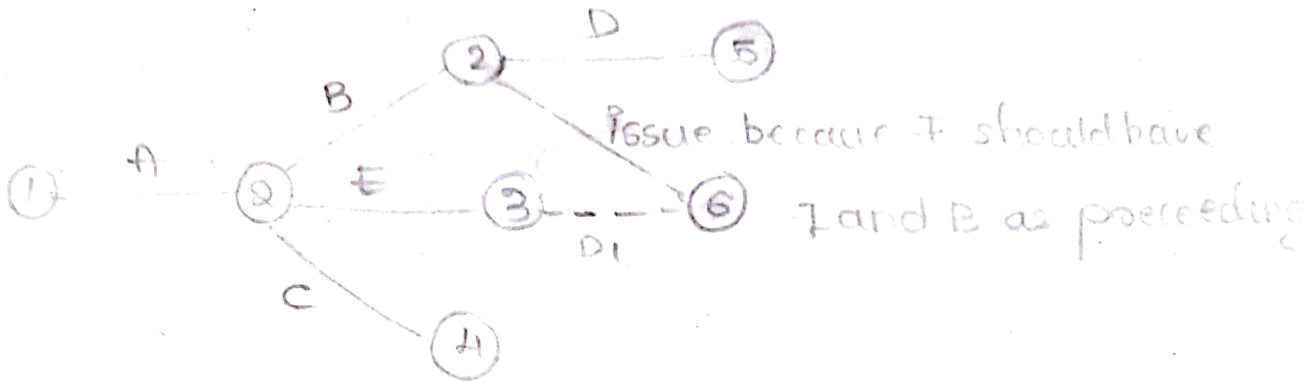


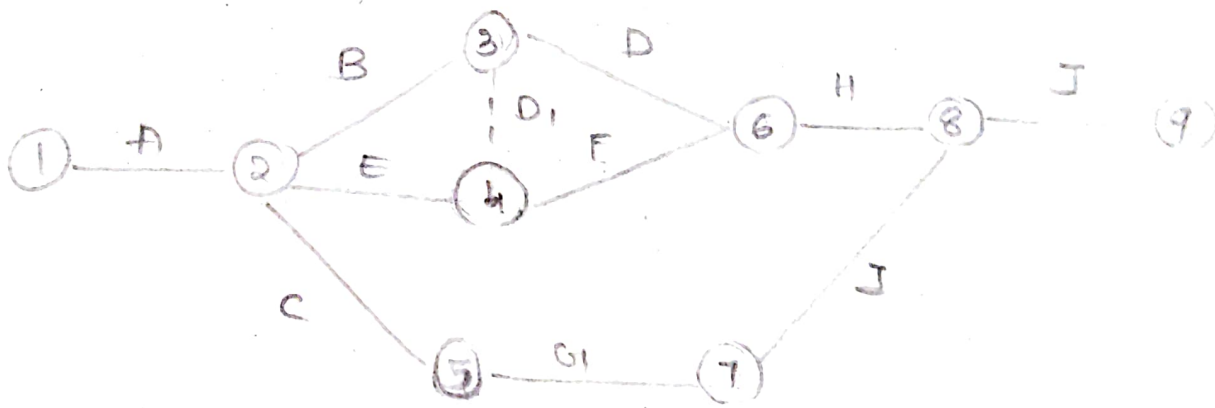
Here D_1 is the dummy activity which consume no time for any resource. ie; a dummy activity is used to simply represent the connection b/w the events. A dummy activity may be represented in a network using dotted arrow.

(2) Draw a network diagram for the following data.

	Activity (i, j)	Preceeding Activity
1)	A	none
	B	A
	C	A
	D	B
	E	A
	F	B, E
	G	C

H	D F
I	G
J .	H I

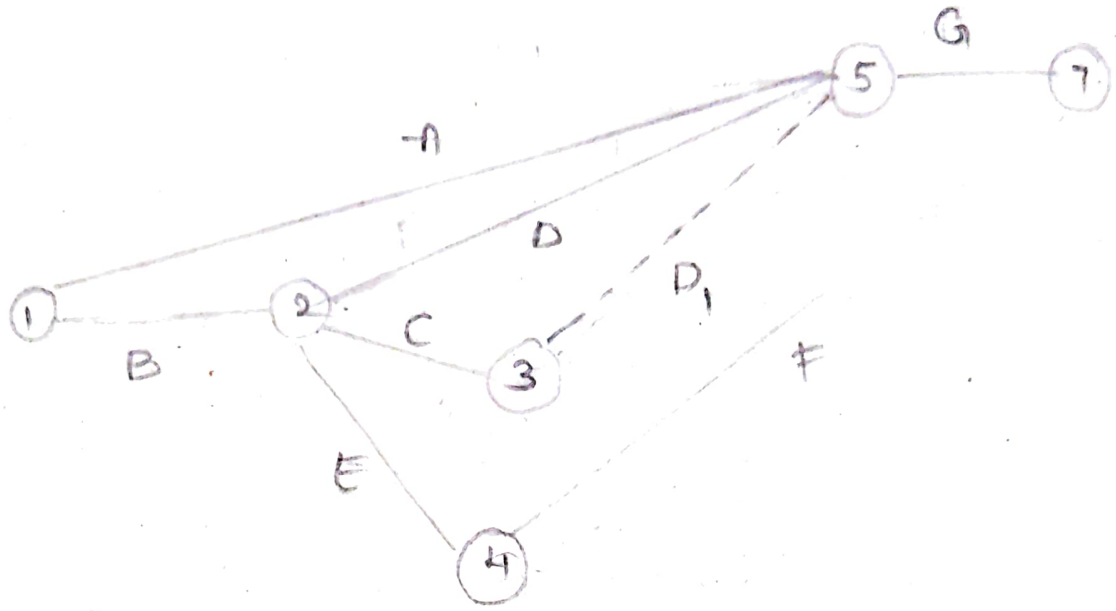


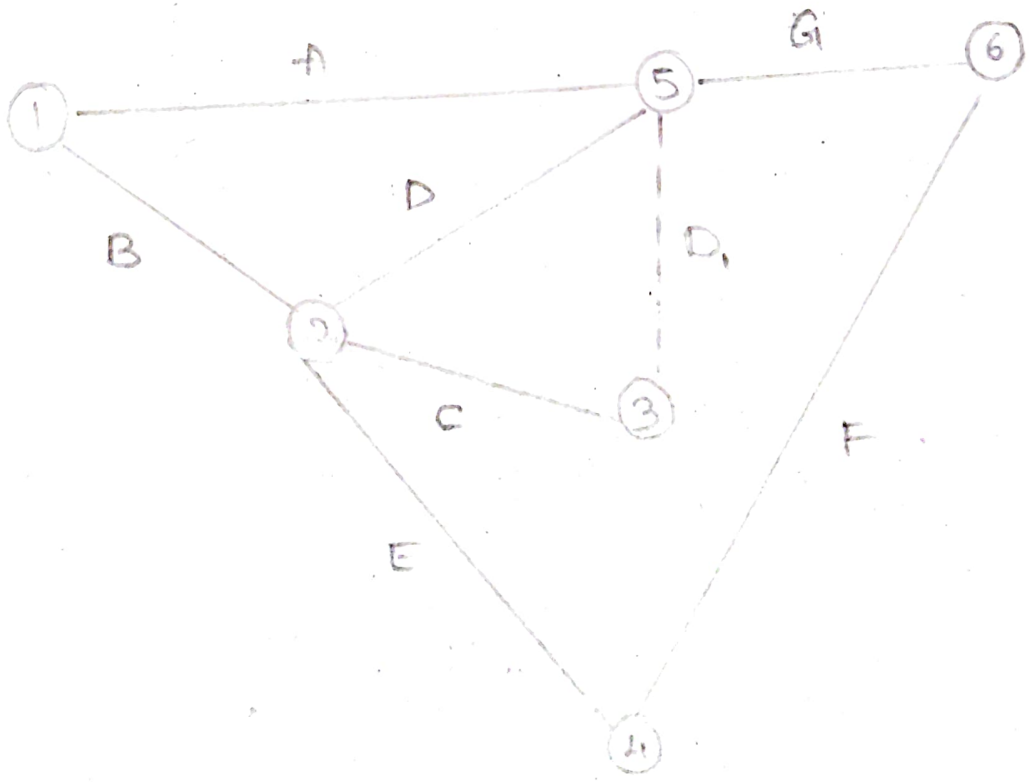


2)

Activity	Immediate predecessor
A	none
B	none .
C	B
D	B
E .	B

F	E
G	A D C .





3) (i) A B and C are the first activities of the project

(ii) A and B preceeds D

(iii) D preceeds E F and H.

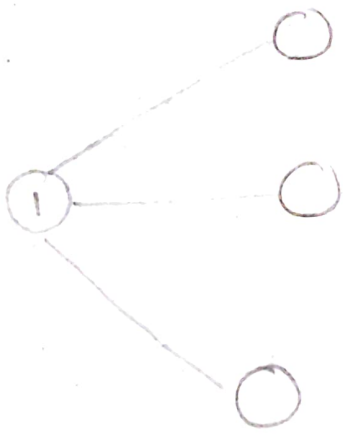
(iv) F and C preceeds G.

(v) E and H preceeds I and J

(vi) C, D, F and J preceeds K.

(vii) K preceeds L.

(viii) J, G and L are terminal activities.



(4)

1. CPM

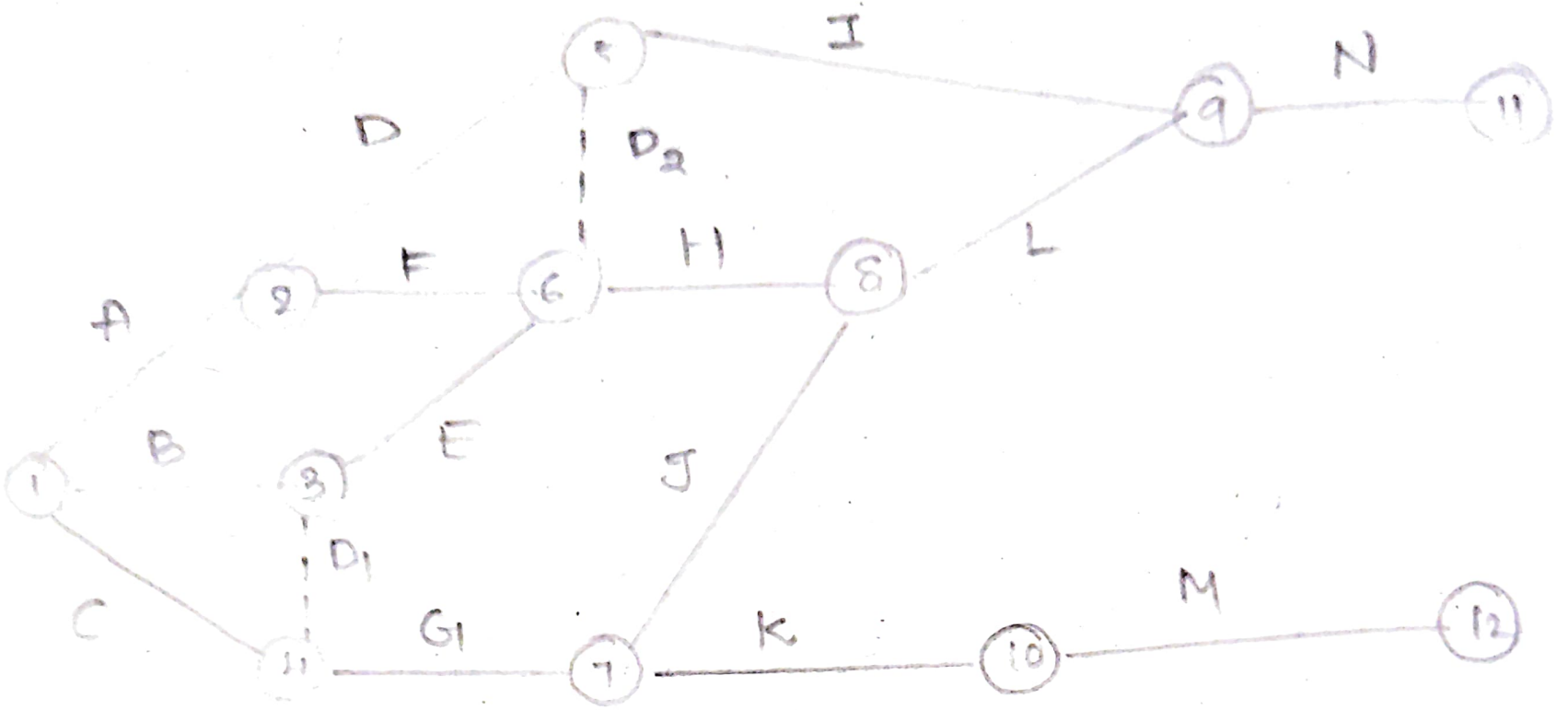
Critical Path Method

It is a method to manage big project that consist of large no: of activities which can cause problems in planning scheduling and control. In CPM it does not incorporate uncertainities in jobtimes instead it assumes that activity times are proportional to the amount of resources allocated to them and by changing the ~~ke~~ k value of resources ~~that~~ activity times and the project completion time can be varied. Thus, CPM assumes prior experience with similar project from which the relationship b/w resources and job time are available.

CPM then evaluates the tradeoff b/w project cost and project completion time. CPM is mostly used in construction projects where there is prior experience in handling similar projects.

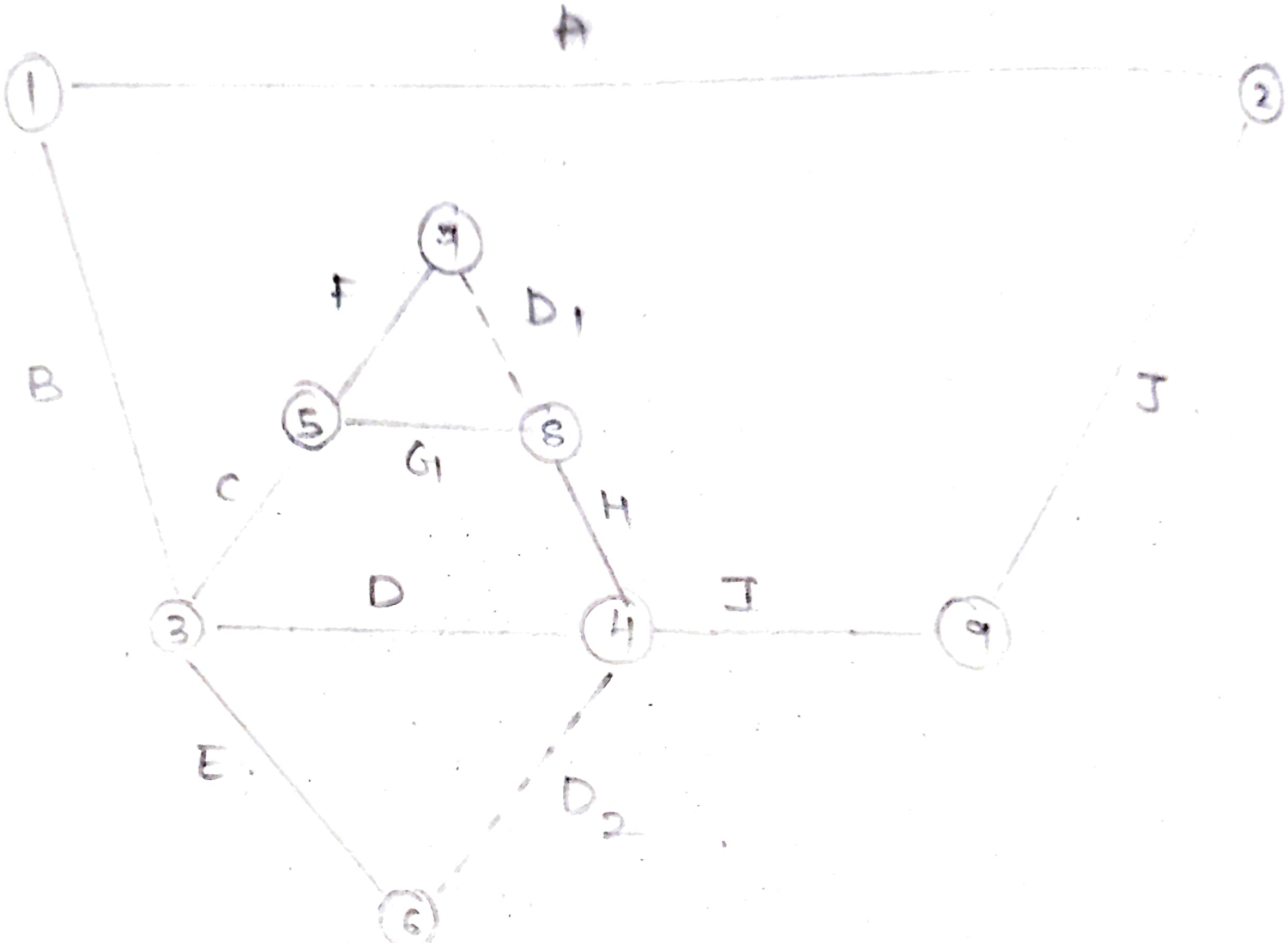
(4) Draw the network diagram for the following

Activity	Immediate predecessor
A	null
B	null
C	null
D	A
E	B, C
F	A
G	C
H	D, E, F
I	D
J	G
K	G
L	H, J
M	K
N	I, L


I
N
D
D2
F
H1
L
A
B
E
J
D1
C
G1
K
M
1
2
3
4
5
6
7
8
9
10
11
12

⑤ Following are the activities which are to be performed for a building site preparation: for maintance on heat exchange in a refinary.

Activity	Description	Preceedesecce activity
A	Dismanlt pipeconnection	A
B	Dismanlt header, closure and floating font	B
C	Remove tube bundle.	B
D	be clean bolts.	B
E	clean header and floating head.	B
F	clean tube bundle.	C
G	clean shell	C
H	Replace tube bundle.	F, G.
I	Prepare shell. bundle. pressure test.	D, E, H.
J	Reassemble.	I.


A
1
2
7
F
D1
B
J
5
8
G1
C
H
D
3
4
J
9
E
D2
6

Critical Path Analysis

The purpose of analysis is to find the critical path ie; the sequence of activity with the longest duration and to find the float associated with each non critical activity. An activity in a network diagram is said to be critical if the delay in its start will further delay the projection completion time. The non critical activity allow some slack time so that the start time of the activity may be advanced or delayed within limits without affecting completion date of the entire project.

To accomplish the above mentioned objectives, the following factors should be known.

1) Time schedule for each activity is the time by which an activity must begin and time before which it is completed

2) Earliest and latest start time as well as earliest and latest finish of each activity

3) Float for each activity ie; the spare time associated with each activity.

4) Critical activity and critical path.

Note:

E_i = earliest occurrance time of event I.

L_j = latest occurrance time of event j

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

The critical ~~path~~ pass calculation are seen in two ways.

1. Forward pass calculation
2. Backward pass calculation

1 Forward Pass Calculation

1. We start from initial node 1 with starting time of project as 0. At each node we calculate

the early start and finish time of each activity by considering F_i as the earliest occurrance of node i, the method can be summarised as follows,

1. Set $F_1 = 0$; $i = 1$ (initial node)

step 2: Set earliest start time for each activity that begins at node i as.

$$ES_{ij} = E_i$$

$\forall$ activites (i,j) that start at node i

step 3: Earliest finish time.

$$EF_{ij} = ES_{ij} + t_{ij}$$
$$= E_i + t_{ij}$$

step 4: For the nextnode j $(j > i)$ the earliest occurrance $E_j = \max_i \{EF_{ij}\}$

$$= \max_i \{E_i + t_{ij}\}.$$

step 5: If $j = n$ (final node) the earliest finish time

$$F_n = \max \{ EF_{ij} \}$$

$$= \max \{ E_{(n-1)} + \overset{t}{F}_{ij} \}.$$

Note:

① Float / Slack of an activity and event

The float of an activity is the time by which it is possible to delay its completion time without affecting the total project completion time.

1. Event Float

The float or slack of an event is the difference b/w its latest time L_i and its earliest time E_i

ie; event float $= L_i - E_i$

2. Activity Float

It is the float or slack in the activity time estimates. There are mainly 3 types of activity float

1. Total float
2. Free float

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3. Independent float

1. Total Float

- The total float of an activity represents the amount of time by which an activity can be delayed without delay in the project completion time

$$\text{Total Float, } TF_{ij} = L_j - (E_i + t_{ij})$$

2. Free Float

- The free float is that position of the total float within which an activity can be manipulated without affecting subsequent activity

3. Independent Float

- It is that position of the total float within which can activity can be delayed for start without affecting flows of preceeding activity

$$\text{Free Float, } FF_{ij} = (E_j - E_i) - t_{ij} = E_j - (E_i + t_{ij})$$

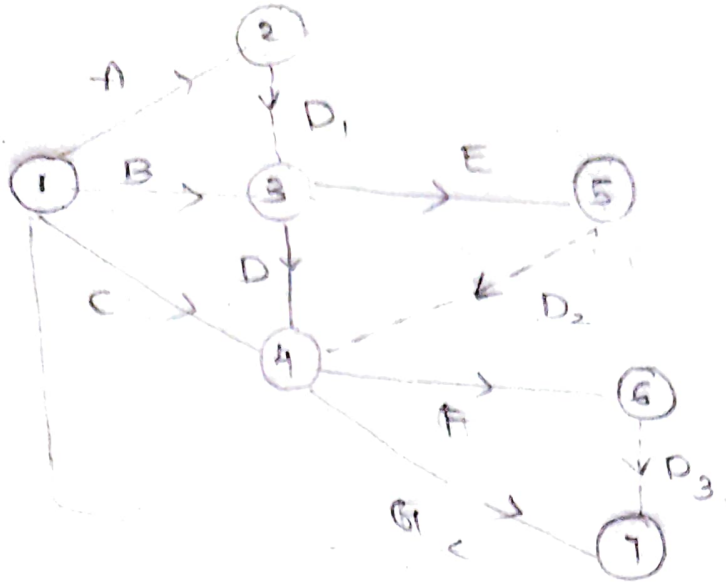
$$\text{Independent float, } IF_{ij} = (E_j - L_i) - t_{ij}$$

① A project consist of 7 activities for which the relavant data are given below

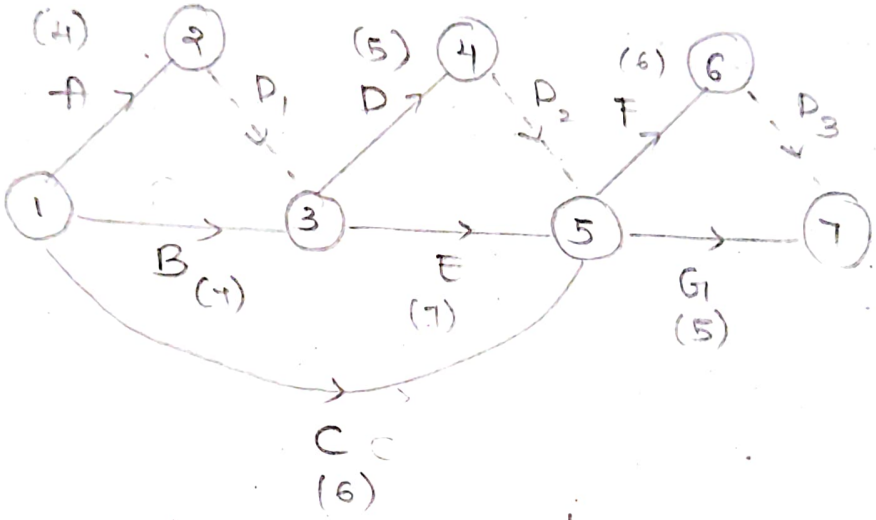
Activity	Preceeding Activity	Duration (days)
A	-	4
B	-	7
C	-	6
D	A, B	5
E	A, B	7
F	C, D, E	6
G	C, D, E	5

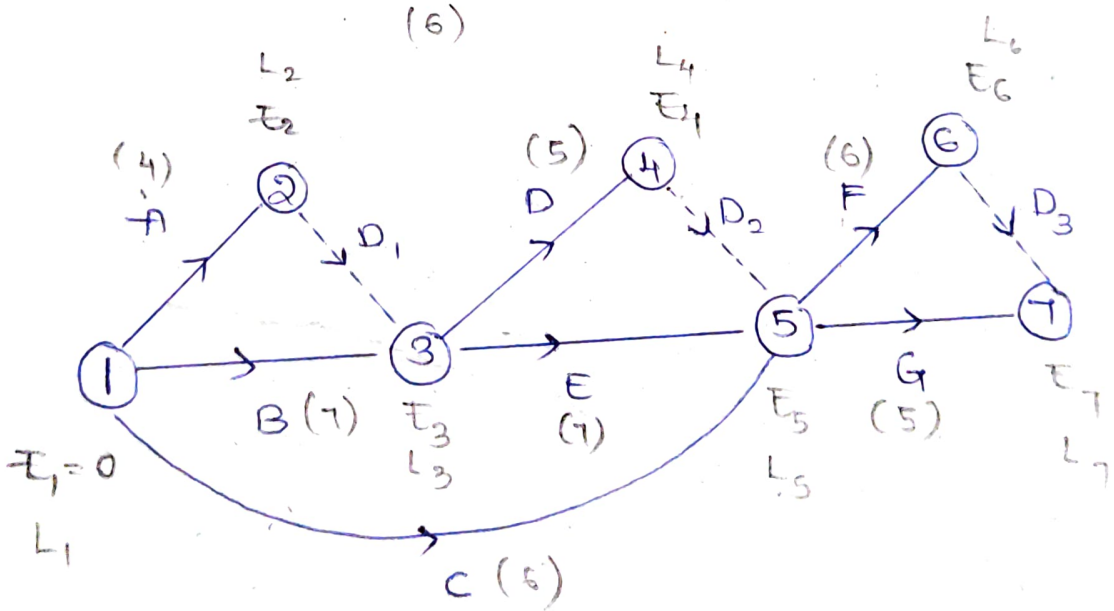
a) Draw the network and find the project completion time

b) Calculate total float for each of the activity and highlight the critical path.



Redrawing





Foreward passing

$E_1 = 0$

$E_2 = 0 + 4 = 4$
(A)

$E_3 = \max\{ 0+4+0 , 0+7 \}$ → more than 1 activity so take maximum

DAD, OB

$= \max\{4, 7\}$

$= 7$

$E_4 = 7+5$

(D)

$= 12$

$E_5 = \max\{ 12+0, 7+7 \}$

$E_4 D_2$ $E_3 E$

$= \max\{12, 14\}$

$= 14$

$E_6 = 14+6$

$E_5 F$

$= 20$

$E_7 = \max\{ 20+0, 14+5 \}$

$E_6 D_3$ $E_5 G$

$= \max\{20, 19\}$

$= 20$

Backward Passing.

$L_7 = \underline{20}$

$L_6 = 20 - 0 = \underline{20}$
$L_7 D_3$

$L_5 = \min\{20-6, 20-5\}$ ⟶ more than 1 activity so take minimum.
$L_6 F \quad L_7 G$

$= \min\{14, 15\}$

$= \underline{14}$

$L_4 = 14 - 0 = \underline{14}$
$L_5 D_2$

$L_3 = \min\{14-2, 14-7\}$
$L_4 D \quad L_5 E$

$= \min\{9, 7\}$

$= \underline{7}$

$L_2 = 7 - 0$
$L_3 D_1$

$= \underline{7}$

$L_1 = \min\{7-4, 7-7, 14-6\}$
$L_2 A \quad L_3 B \quad L_5 C$

$= \min\{3, 0, 8\}$

$= \underline{0}$