Network Scheduling by CPM and PERT (Project Management)

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Important Questions:

1. Explain the rules of constructing a network.

Ans:

The following are some basic rules to construct a network of a project with events(with circles) and activities(with arrows) in a logical manner.

i) Network starts and ends in an event and time flows from left to right

ii) No event can occur until every activity preceding it has been completed.

iii) An activity succeeding an event cannot be started until that event has occurred.

iv) An event cannot occur twice.

(avoid formation of loops)

v) Each activity must starts from an event and ends in an event

vi) An activity must be completed in order to reach the end event.

vii) Each activity must be connected with starting and ending event. (avoid dangling)

viii) Dummy activity should be used only if necessary. (Redundant unnecessary dummies)

ix) Unique numbers should be assigned to the events in increasing order from left to right.

2. Explain the forward pass and backward pass time computations in a network.

Ans:

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

EST_{ij} = Earliest starting time of (i,j)

EFT_{ij} = Earliest finishing time of (i,j)

E_i = Earliest occurrence time of ith event

LST_{ij} = Latest starting time of (i,j)

LFT_{ij} = Latest finishing time of (i,j)

L_i = Latest occurrence time of ith event

(Earliest Starting Time of an activity means earliest possible time when the activity can begin.

Latest Starting Time of an activity means latest time at which the activity can start if target time of project is to be maintained.)

Forward Pass time calculations:

(Earliest times)

-> Starting time of project = 0

i.e.,E1=0 and $EST_{1j} = 0$ for all possible j=2,3,...

-> $EFT_{ij} = EST_{ij} + t_{ij}$ for all (i,j)

-> $E_j = EFT_{ij}$, if j^{th} event is non-merge event

$E_j = \max_i\{EFT_{ij}\}$, if jth event is merge event

-> $EST_{ij} = E_i$

-> E_n = Earliest occurrence time of end event

or Project duration (target time)

Backward Pass time calculations:

(Latest times)

-> L_n = Latest time of end event = E_n

-> $LFT_{ij} = L_j$

-> $LST_{ij} = LFT_{ij} - t_{ij}$

-> $L_i = LST_{ij}$, if i^{th} event is non-brust event

$L_i = \min_j\{LST_{ij}\}$, if jth event is brust event

-> $L_1 = 0$

Float/Slack times:

Float/Slack = Available time – Required time

(excess time available)

->float related to activity, slack related to event

-> Total float = LFT_{ij}-EST_{ij}-t_{ij}

3. Explain Critical Path Method.

Ans:

Critical Activity: An activity is said to critical If its total float = 0.

(or) If delay in an activity results in delay of project, the activity is called critical activity.

Critical Path: The path connecting critical activities is called a critical path.

-> critical path may not be unique in a project

-> In CPM, t_{ij} are deterministic.

Critical Path Method (CPM):

1. Draw a network by identifying all events and activities of the project applying the rules
2. Indicate the time durations (t_{ij}) on the arrows representing the activity.
3. Calculate the Earliest times for each activity and each event and mark the event earliest time in the box 

4. Calculate the Latest times for each activity and each event and mark the event latest time in the box 

5. Tabulate the timings of each activity and calculate the total float.
6. Identify the critical activities for which total float is zero.
7. Identify the critical path by double line arrows in the network
8. Find the optimum total project duration, which is the finishing time of end event.

4. Write the differences between CPM and PERT and Describe the PERT Algorithm.

Ans:

CPM

- Activity-oriented
- Time durations of activities are well known
- Deterministic model
- Used in repetitive jobs like constructions

PERT

- Event-oriented
- Time durations of activities are uncertain
- Probabilistic model
- Used in non-repetitive jobs like planning and scheduling

Project Evaluation and Review Technique (PERT)- Algorithm:

1. Draw a network by identifying all events and activities of the project applying the rules
2. Calculate the expected time t_e for each activity by using the formula,

   $t_e = (t_p+4t_m+t_o)/6$

   where, t_p = pessimistic time

   t_m = most likely time

   t_o = optimistic time
3. Indicate the expected time durations (t_e) on the arrows representing the activity.

4. Calculate and tabulate the Earliest and latest times for each activity and each event and mark E and L times at the respective events in the network.
5. Calculate the total float and identify the critical activities and critical path by double arrows.
6. Find the expected time of completion of project.
7. Calculate the variances of each activity's time estimates by the formula,

$$\sigma^2 = [(t_p - t_o)/6]^2$$

8. Fine the probability of completing the project within the scheduled time using standard normal tables and calculating the standard normal ordinate,

$$Z = (\text{schedule time} - \text{expected duration})/\sqrt{(\text{project variation})}$$

here, project variation = sum of variances of critical activities

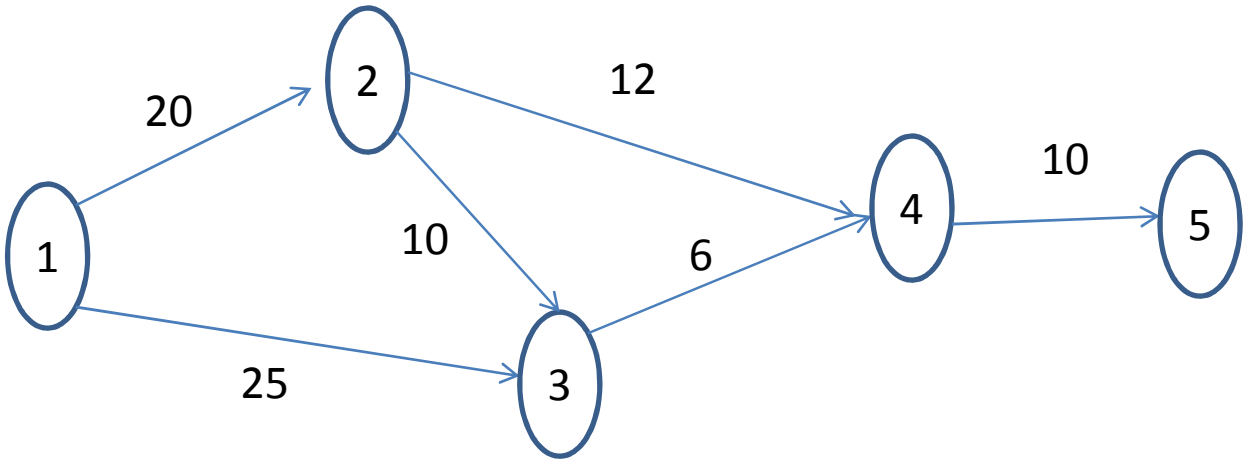
5. The following table gives the activities of a construction project and duration.

Activity : 1-2 1-3 2-3 2-4 3-4 4-5

Duration: 20 25 10 12 6 10

i)Draw the network ii)find critical path and project duration

Ans: Network



Time calculations:

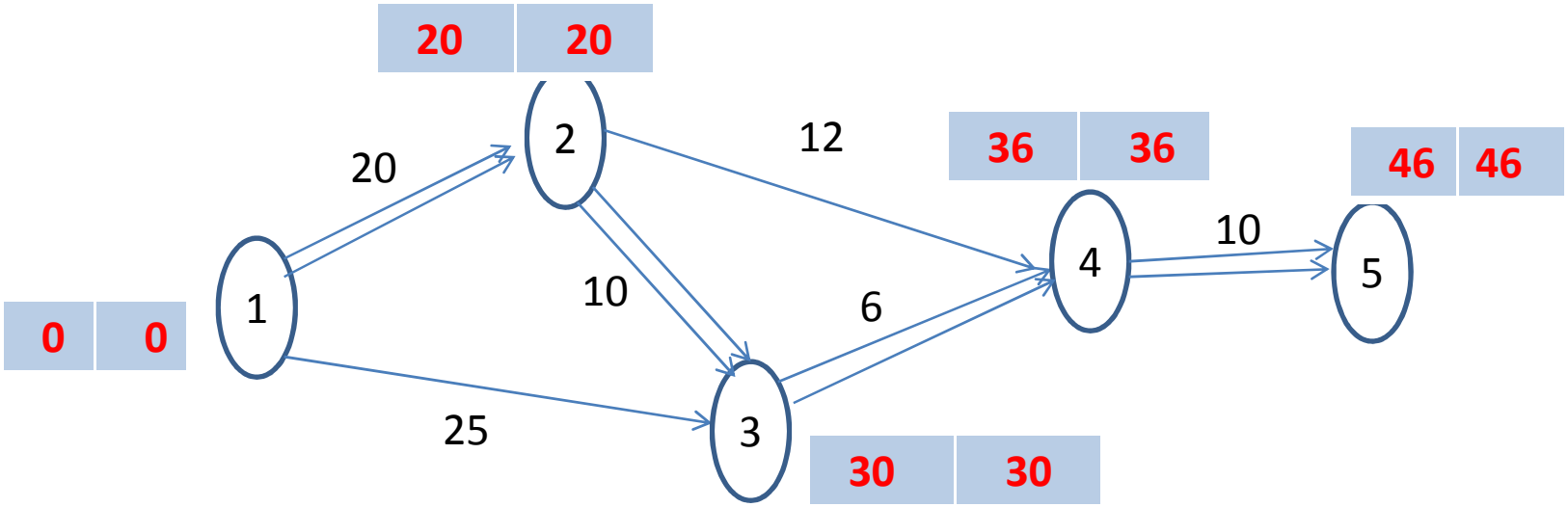
Earliest times

- E1 = 0 = EST12 = EST13
- EFT12 = EST12 + t12 = 0 + 20 = 20
  => E2 = EFT12
  => E2 = 20 = EST23=EST24
- EFT13 = EST13 + t13 = 0 + 25 = 25
  EFT23 = EST23 + t23= 20 +10= 30
  => E3 = Max{25, 30} (merge event)
  => E3 = 30 = EST34
- EFT24 = EST24 + t24= 20 + 12 = 32
  EFT34 = EST34+t34 = 30 + 6 = 36
  => E4 = max{32, 36} (merge event)
  E4 = 36 = EST45
- EFT45 = EST45+t45 = 36 + 10 =46
  => E5 = EFT45
  => E5 = 46

Latest times

- L5 = E5= 46 = LFT45
- LST45 = LFT45 – t45 = 46 - 10 =36
  => L4 = LST45
  => L4 = 36 = LFT24=LFT34
- LST34 =LFT34 – t34 =36 -6 = 30
  => L3 = LST34
  => L3 = 30 = LFT13=LFT23
- LST24 = LFT24 - t24= 36 - 12 = 24
  LST23= LFT23-t23 = 30 – 10 =20
  => L2 = Min{24, 20} (brust event)
  => L2 = 20 = LFT12
- LST12 =LFT12-t12 = 20 -20 =0
  LST13 = LFT13 – t13 = 30-25=5
  => L1 = Min{0, 5} (brust event)
  => L1 = 0

Activity	Duration (t)	EST	EFT	LST	LFT	Total float (LFT-FST-t)
1-2	20	0	20	0	20	0
1-3	25	0	25	5	30	5
2-3	10	20	30	20	30	0
2-4	12	20	32	24	36	4
3-4	6	30	36	30	36	0
4-5	10	36	46	36	46	0



Critical path: 1->2->3->4->5 and project duration = 46