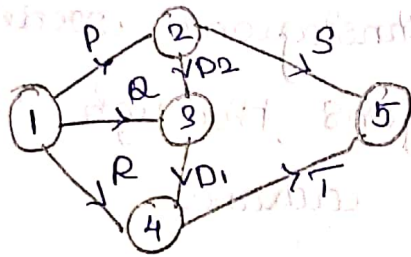


1) If they are five activities P, Q, R, S, T such that P, Q, R have no immediate predecessors but S and T have immediate predecessors P, Q and Q, R respectively. Represent the condition

No immediate predecessors P, Q, R.
 Immediate predecessors S, T.

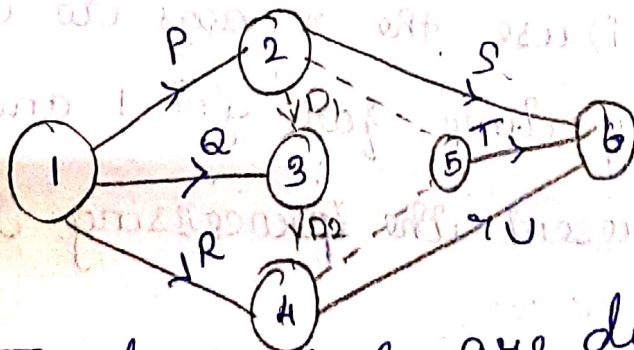


The d_1 and d_2 are dummy activities.

2) Draw the network of ^{Project} ~~project~~ whose the activities on the predecessor relationship are given below.

Activity : P Q R S T U

Predecessor : - P, Q P, R Q, R



The d_1, d_2, d_3, d_4 are dummy activities

3) Draw the network of project whose the activities and the predecessor relationship are given below

A, C, D can start simultaneously;

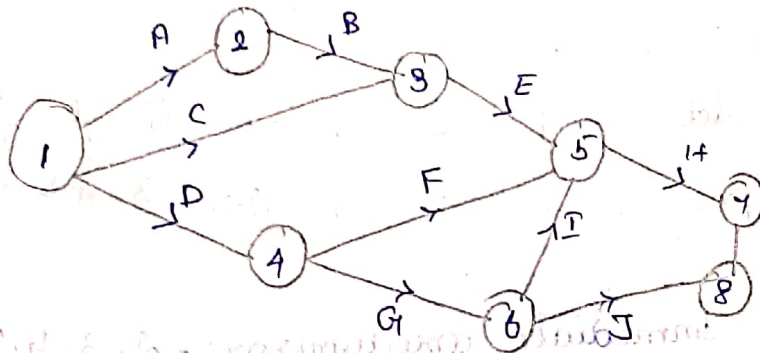
E > B, C; F, G > D; H, I > E, F;

J > I; K > H; B > A

A, C, D are no immediate predecessor.

~~E > B, C~~

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|------|---|---|------|------|------|---|---|
| - | A | - | B, C | D | D | E, F | E, F | I, G | H | - |



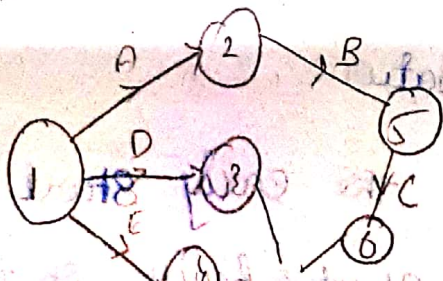
H/W

1) construct the network for the project whose activities and their relationship are as given below

activity : A, D, E can start simultaneously

Predecessors : B, C > A; G, F > D, C; H > E, F.

| A | B | C | D | E | F | G | H |
|---|---|---|------|------|---|---|---|
| - | - | - | D, C | E, F | - | - | - |

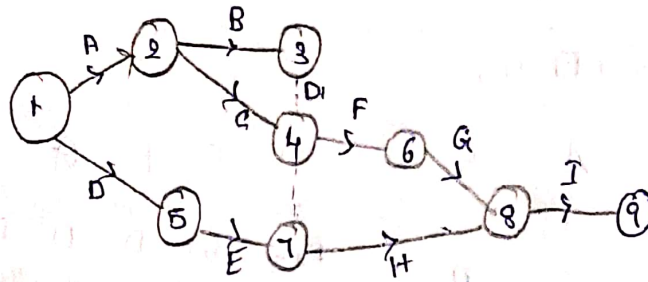


5. Activities : A B C D E F G H I

Predecessors : - A A - D B & E F E G, H

Immediate predecessor - B, C, E, F, G, H, I.

No immediate predecessor - A, D.

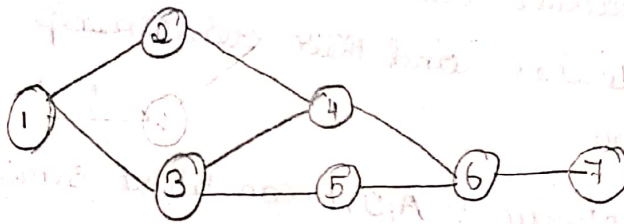


6. Act : 1 2 3 4 5 6 7

Pre : - 1 1 2,3 3 4,5 5,6

Immediate predecessor - 2, 3, 4, 5, 6, 7

No immediate predecessor - 1

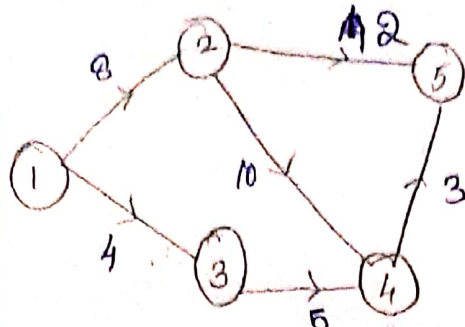


7. Act : 1-2 1-3 2-4 2-5 3-4 4-5.

Pre : 8 4 10 2 5 3

Network computations.

compute the early start and early finish latest start & finish of the each activities of the project.



$$1-2-5 = 8 + 2 = 10$$

$$1-2-4-5 = 8 + 10 + 3 = 21$$

$$1-3-4-5 = 4 + 5 + 3 = 12$$

The critical path 1-2-4-5

| Act | Duration D _{ij} | Earliest | | Latest | |
|-----|-----------------------------|-------------|--------------|-------------------------------------|--------------|
| | | Start FS | Finish EF | Start LS LF + t _{ij} | Finish LF |
| 1-2 | 8 | 0 | 8 | 0 | 8 |
| 1-3 | 4 | 0 | 4 | 9 | 13 |
| 2-4 | 10 | 8 | 18 | 8 | 18 |
| 2-5 | 2 | 8 | 10 | 19 | 21 |
| 3-4 | 5 | 4 | 9 | 13 | 18 |
| 4-5 | 3 | 18 | 21 | 18 | 21 |

Float

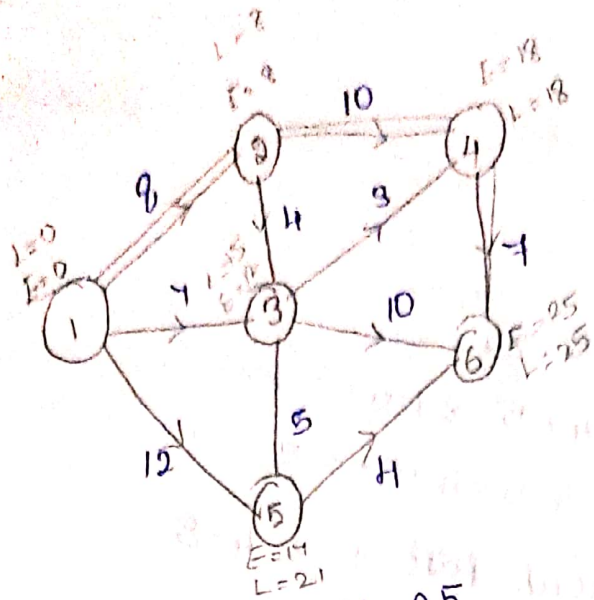
calculate the total float, free float, and independent float for a project.

Activities : 1-2 1-3 1-5 2-3 2-4

Duration : 8 7 12 4 10

3-4 3-5 3-6 4-6 5-6

5 10 7 4



$$1-2-4-6 = 8 + 10 + 7 = 25$$

$$1-2-3-4-6 = 8 + 4 + 3 + 7 = 22$$

$$1-3-6 = 7 + 10 = 17$$

$$1-3-5-6 = 7 + 5 + 4 = 16$$

$$1-5-6 = 12 + 4 = 16$$

The critical path = 1-2-4-6 in the duration 25 week.

| Activities | Duration | Earliest | | Latest | |
|------------|----------|----------|--------|--------|--------|
| | | Start | Finish | Start | Finish |
| 1-2 | | | | | |
| 1-3 | | | | | |

Total float = latest finish - earliest finish.

Free float = Total float - (L-S) of jth event

$$F.F. (1-5) = 9 - (21 - 17) = 9 - 4 = 5$$

| Activities | Duration | Earliest | | Latest | | Floats | | |
|------------|----------|----------|----|--------|-----|--------|----|----|
| | | E.S | EF | L.S | L.F | T.F | FF | TF |
| 1-2 | 8 | 0 | 8 | 0 | 8 | 0 | 0 | 0 |
| 1-3 | 7 | 0 | 7 | 8 | 15 | 8 | 5 | 5 |
| 1-5 | 12 | 0 | 12 | 9 | 21 | 9 | 5 | 5 |
| 2-3 | 4 | 8 | 12 | 11 | 15 | 9 | 0 | 0 |
| 2-4 | 10 | 8 | 18 | 8 | 18 | 9 | 0 | 0 |
| 3-4 | 10 | 12 | 15 | 15 | 18 | 0 | 3 | 0 |
| 3-5 | 5 | 12 | 17 | 16 | 18 | 3 | 0 | -3 |
| 3-6 | 10 | 12 | 22 | 15 | 21 | 4 | 0 | 0 |
| 4-6 | 7 | 18 | 25 | 18 | 25 | 3 | 0 | 0 |
| 5-6 | 4 | 17 | 21 | 21 | 25 | 4 | 4 | 0 |

Date :

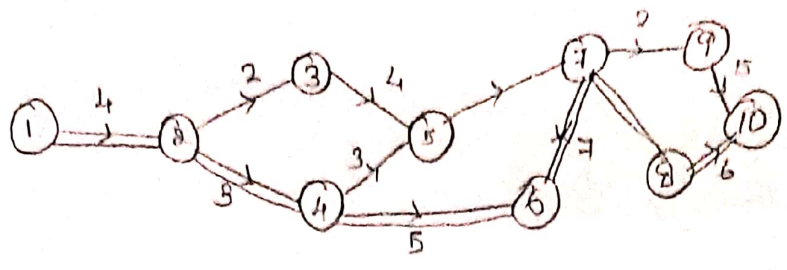
The Problem evolution

[PERT]

construct the network for the project whose activities and the three activities (in weeks) are given below. compute

- Expected duration of ~~each~~ each activity
- Expected variance of each activity
- Expected variance of the project length.

| Activity | t_o Least time | t_m most likely time | t_p greatest time |
|----------|------------------|------------------------|---------------------|
| 1-2 | 3 | 4 | 5 |
| 2-3 | 1 | 2 | 3 |
| 2-4 | 2 | 3 | 4 |
| 3-5 | 3 | 4 | 5 |
| 4-5 | 1 | 3 | 5 |
| 4-5 | 3 | 5 | 7 |
| 4-6 | 4 | 5 | 6 |
| 5-7 | 6 | 7 | 8 |
| 6-7 | 2 | 4 | 6 |
| 7-8 | 2 | 4 | 6 |
| 7-9 | 1 | 2 | 3 |
| 8-10 | 4 | 6 | 8 |
| 9-10 | 3 | 5 | 7 |



- 1-2-3-5-7-9-10 = 22
- 1-2-4-5-7-9-10 = 22
- 1-2-4-6-7-8-10 = 29
- 1-2-3-5-7-8-10 = 25
- 1-2-4-6-7-9-10 = 26

The critical part
 1-2-4-6-7-8 = 10 the project length
 29 weeks.

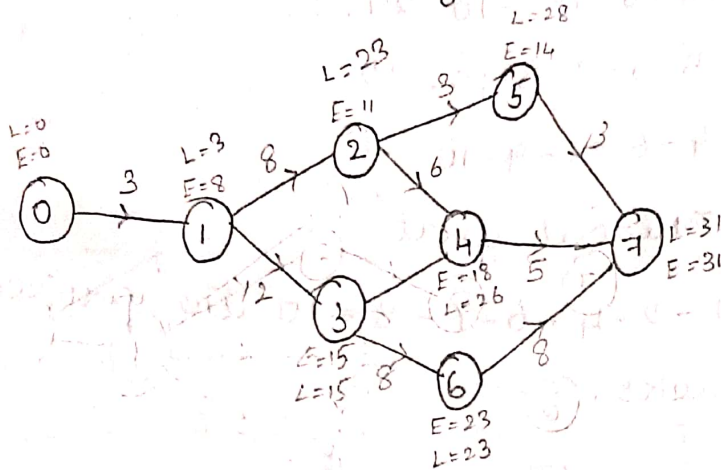
| Activity | to | tm | tp | Expected to duration | Expected σ^2 variance |
|----------|----|----|----|----------------------|------------------------------|
| 1-2 | 3 | 4 | 5 | 4 | 0.11 |
| 2-3 | 1 | 2 | 3 | 2 | 0.11 |
| 2-4 | 2 | 3 | 4 | 3 | 0.11 |
| 3-5 | 3 | 4 | 5 | 4 | 0.11 |
| 4-5 | 1 | 3 | 5 | 3 | 0.44 |
| 4-6 | 3 | 5 | 5 | 5 | 0.44 |
| 5-7 | 4 | 5 | 7 | 7 | 0.11 |
| 6-7 | 6 | 7 | 6 | 4 | 0.11 |
| 7-8 | 2 | 4 | 8 | 2 | 0.44 |
| 7-9 | 2 | 8 | 6 | 2 | 0.11 |
| 8-10 | 1 | 6 | 3 | 6 | 0.44 |
| 9-10 | 4 | 6 | 8 | 5 | 0.44 |

1. Activity : 0-1 1-2 1-3 2-4 2-5 3-4

Dur : 3 8 12 6 3 3

3-6 4-7 5-7 6-7

8 5 3 8



$$0-1-2-5-7 = 3+8+3+3 = 17$$

$$0-1-3-6-7 = 3+12+8+8 = 31$$

$$0-1-2-4-7 = 3+8+6+5 = 22$$

$$0-1-3-4-7 = 3+12+3+5 = 23$$

The critical part

$$0-1-3-6-7$$

Total float = latest finish - earliest finish

Free float = total float - (L - S) of j^{th} event

Independent float = total float - (E - S) of i^{th} event.

(18-26)
14

| Activity | Production | | Exhibit | | Retail | | Flood | |
|----------|------------|-----|---------|-----|--------|-----|-------|----------------------------|
| | E.S | E.F | L.S | L.F | T.F | F.F | T.F | F.F |
| 0-1 | 3 | 3 | 0 | 3 | 0 | 3 | 0 | 5 |
| 1-2 | 8 | 16 | 15 | 28 | 15 | 28 | 7 | 5 |
| 1-3 | 12 | 20 | 3 | 15 | 3 | 15 | 5 | 5 |
| 2-4 | 6 | 17 | 20 | 26 | 20 | 26 | 9 | 5 ¹⁷ |
| 2-5 | 3 | 14 | 25 | 28 | 25 | 28 | 14 | 0 |
| 3-4 | 3 | 18 | 23 | 26 | 23 | 23 | 8 | 10 |
| 3-6 | 8 | 23 | 15 | 31 | 15 | 31 | 0 | 0 |
| 4-7 | 5 | 23 | 26 | 31 | 26 | 31 | 8 | 8 |
| 5-7 | 3 | 17 | 28 | 31 | 28 | 31 | 14 | 14 |
| 6-7 | 8 | 31 | 23 | 31 | 23 | 31 | 0 | 0 |

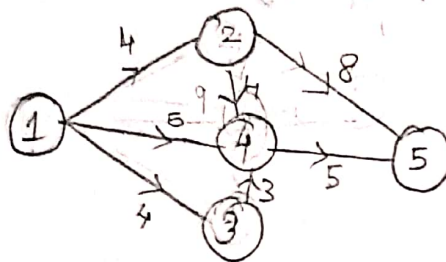
The expected variance of the sum of the
Expected variance of critical activities.

$$0.11 + 0.11 + 0.44 + 0.11 + 0.44 + 0.44$$

$$= 1.6500.$$

a. Activity :

| | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----|
| | 1-2 | 1-3 | 1-4 | 2-4 | 2-5 | 3-4 | 4-5 |
| a | 2 | 3 | 4 | 8 | 6 | 2 | 2 |
| m | 4 | 4 | 5 | 9 | 8 | 8 | 5 |
| b | 5 | 6 | 6 | 11 | 12 | 4 | 7 |



~~$$1-2-4-5 = 4 + 9 + 5 = 18$$~~

~~$$1-4-5 =$$~~

~~$$1-3-4-5 =$$~~

$$1-3-4-5 = 4 + 3 + 5$$

$$= 12$$

$$1-4-5 = 5 + 5 = 10$$

The critical path

1-2-4-5 the project length of 18 weeks.

| Activity | a | m | b | Expect to duration $t_e = \frac{t_o + 4t_m + t_p}{6}$ | Expect variance $\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$ |
|----------|---|---|----|--|--|
| 1-2 | 2 | 4 | 5 | $\frac{3.88}{5}$ | $\frac{0.25}{5}$ |
| 1-3 | 3 | 4 | 6 | $\frac{2.16}{5}$ | $\frac{0.25}{5}$ |
| 1-4 | 4 | 5 | 6 | $\frac{9.16}{9}$ | $\frac{0.11}{9}$ |
| 2-4 | 8 | 9 | 11 | $\frac{8.88}{8}$ | $\frac{0.25}{8}$ |
| 2-5 | 6 | 8 | 12 | 0.3 | 0.11 |
| 3-4 | 2 | 3 | 4 | $\frac{4.88}{5}$ | $\frac{0.69}{5}$ |
| 4-5 | 2 | 5 | 7 | | |

$$8.88 + 9.16 + 4.88 + 0.25 + 0.25 + 0.25 + 0.69$$

$$= 19.9$$

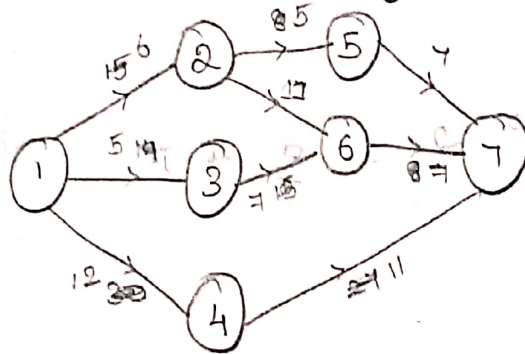
$$\sigma = \sqrt{1.19}$$

$$\sigma = 1.09$$

| Activity | Least time | Greatest time | Most likely time |
|----------|------------|---------------|------------------|
| 1-2 | 3 | 15 | 6 |
| 1-3 | 2 | 14 | 5 |
| 1-4 | 6 | 30 | 12 |
| 2-5 | 2 | 8 | 5 |
| 2-6 | 5 | 17 | 4 |
| 3-6 | 3 | 15 | 6 |
| 4-7 | 3 | 27 | 9 |
| 5-7 | 1 | 7 | 4 |
| 6-7 | 2 | 8 | 5 |

i) Draw network

ii) what is the probability that project completion 27 days.



To find the critical path

$$1-2-5-7 = 30$$

$$1-3-6-7 = 37$$

$$1-2-6-7 = 40$$

$$1-4-7 = 57$$

The critical path is 1-4-7 and the duration of project is 57 days.

| Activity | (a) Reast time | (m) Greatest time | (b) M.E.T | Expected duration | Expected Variance |
|----------|----------------------|-------------------------|--------------|----------------------|----------------------|
| 1-2 | 3 | 15 | 6 | 697.46 | 0.254 |
| 1-3 | 2 | 14 | 5 | 686 | 0.254 |
| 1-4 | 6 | 30 | 14 | 13815.3 | 16 |
| 2-5 | 2 | 8 | 5 | 397.5 | 0.251 |
| 2-6 | 5 | 17 | 11 | 8411 | 4 |
| 3-6 | 3 | 15 | 6 | 697 | 0.254 |
| 4-7 | 3 | 27 | 9 | 12011 | 16 |
| 5-7 | 1 | 7 | 4 | 334 | 0.2516 |
| 6-7 | 2 | 8 | 5 | 345 | 0.251 |

$$\text{Expected duration} = \frac{t_0 + 4t_m + t_p}{6}$$

$$\text{Expected variance } \sigma^2 = \left(\frac{t_p - t_0}{6} \right)^2$$

The ~~Expected duration for the project~~
 length = ~~138 + 120 = 258~~

The ~~Expected variance for the project~~
 length = ~~14 + 11 = 25~~

$$= \sigma^2 = 32$$

$$\sigma = \sqrt{32}$$

$$= 5.656$$

$$Z = \frac{T_B - T_E}{\sigma_C} \quad T_B = 27 \quad T_E = 25 \quad \sigma_C = 5.656$$

$$= \frac{27 - 25}{5.656} = \frac{2}{5.656}$$

$$= 0.35$$

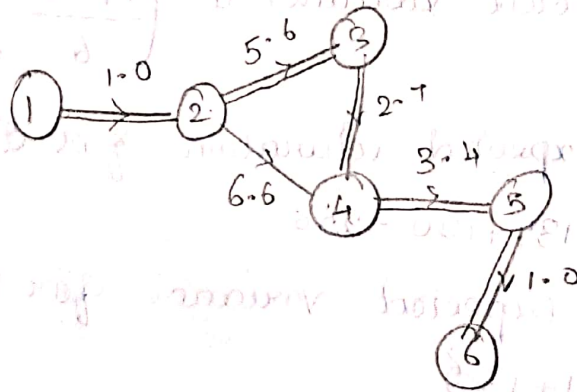
2. Three times Estimates (in months) of all activities of projects are given below.

a) find the expected duration and standard deviation of each activity.

b) construct the project network

| Activity | a | m | b |
|----------|-----|-----|------|
| 1-2 | 0.8 | 1.0 | 1.2 |
| 2-3 | 3.7 | 5.6 | 9.9 |
| 2-4 | 6.2 | 6.6 | 15.4 |
| 3-4 | 2.1 | 2.7 | 6.1 |
| 4-5 | 0.8 | 3.4 | 3.6 |
| 5-6 | 0.9 | 1.0 | 1.1 |

b)



To find critical path

$$1-2-3-4-5-6 \Rightarrow 18.7$$

$$1-2-4-5-6 \Rightarrow 12$$

c) The critical path is 1-2-3-4-5-6 of

the duration project $\Rightarrow 18.7$

| Activity | a | m | b | E.D | E.V | |
|----------|-----|-----|------|------|-------|-------|
| 1-2 | 0.8 | 1.0 | 1.2 | 1 | 4.4 | 0.004 |
| 2-3 | 3.7 | 5.6 | 9.9 | 6 | 1.06 | 1.067 |
| 2-4 | 6.2 | 6.6 | 15.4 | 8 | 2.35 | 2.35 |
| 3-4 | 2.1 | 2.7 | 6.1 | 3.16 | 0.44 | 0.44 |
| 4-5 | 0.8 | 3.4 | 3.6 | 3 | 0.217 | 0.217 |
| 5-6 | 0.9 | 1.0 | 1.1 | 1 | 1.1 | 0.11 |

$$= 1 + 6 \cdot 3.16 + 3 + 1$$

$$= 14.16 = (14)$$

The Expected variance of project

$$= 4.4 + 1.06 + 0.44 + 0.217 + 1.1$$

$$= 7.227$$

→ The expected duration of the project length.

$$= 14 \text{ month.}$$

The Expected variance of project.

$$\sigma^2 = 1.729$$

$$\sigma = \sqrt{1.729}$$

$$\sigma = 1.3149$$

a) The Expected duration of each activity = 37.3.

Expected variance of each activity = 4.07

b.