Q. 1. solution :-

(a) ⟶ (2 2) Normal distribution

(b) ⟶ Marks to all

(c) ⟶ (2 √) Free float

(d) ⟶ (2 2) $\frac{t_o + 4t_m + t_p}{6}$

(e) ⟶ (2 2 2) Zero

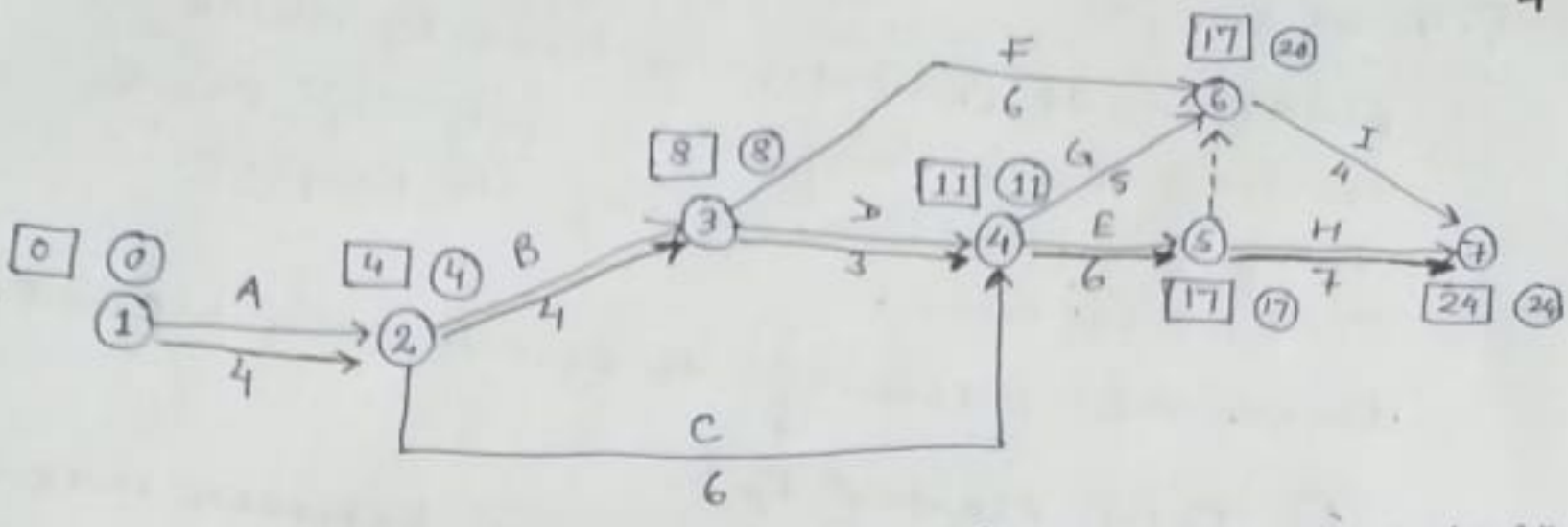
Q.2. Differentiate between CPM and PERT techniques 2

Ans:-

CPM	PERT
↓	↓
(i) CPM is an activity oriented network diagram. i.e Activity oriented technique.	(i) PERT is an event oriented network diagram. i.e event oriented technique.
(ii) CPM based on deterministic approach.	(ii) PERT is based upon probabilistic approach.
(iii) CPM is used for repetitive type of projects. eg: construction	(iii) PERT is used for research and development type project. eg R & D work.
(iv) Only single time estimate is made for each activity in CPM.	(iv) Three time estimates are made for each activity in PERT.

CPM	PERT
(v) In CPM each activity is assumed to follows normal distribution.	(v) In PERT each activity is assume to follows β - distribution.
(vi) In CPM, Cost is not directly proportional to time hence time-Cost models are prepared to find the minimum Project Cost and the corresponding duration.	(vi) In PERT, Cost is assumed to be directly proportional to time hence in order to minimise the cost of project duration of project is reduced.
(vii) CPM stands for Critical path method.	(vii) PERT stands for Project/Programme evaluation and Review Technique
(viii) To know critical path in CPM we calculate floats of activities.	(viii) To know critical path in PERT network we calculate slack of events.

Q. 3. Solution:-



*Critical path is shown with double arrow in network.

□ → stands for Forward Pass

○ → stands for backward Pass

Activity	t_{ij}	EST	EFT	LST	LFT	Total float
A	4	0	4	0	4	0
B	4	4	8	4	8	0
C	6	4	10	5	11	1
D	3	8	11	8	11	0
E	6	11	17	11	17	0
F	6	8	14	14	20	3
G	5	11	16	15	20	1
H	7	17	24	17	24	0
I	4	17	21	20	24	3

Hence Activity having Total float zero is critical activity and path joining these activities called critical path → A → B → D → E → H
① → ② → ③ → ④ → ⑤ → ⑦

Q.4. solution :-

FLOAT :- It indicates the time by which, starting or finishing of an activity can be delayed without affecting the project completion time.

There are following different types of float.

① Total float (F_T)

→ The difference between maximum time available and actual time required for the completion of the activity.

If EST → Earliest starting time
LFT → Latest finishing time
t_{ij} → Actual time required of an activity

then

$$F_T = LFT - EST - t_{ij}$$

It affects the both succeeding as well as preceeding activity because it involves LFT and EST both.

Remark :- Activity having total float zero is called critical activity.

(ii) FREE FLOAT :- (F_F)

It is defind as the amount of time by which an activity can be delayed without affecting the earliest starting time of Succeeding activity.

F_F = Earliest finishing time
- Earliest starting time
- Actual time of an activity

$$F_F = EFT - EST - t_{ij}$$

(iii) INDIPENDENT FLOAT (I_F)

→ It is the amount of time by which an activity can be delayed when all the preceding activities are completed as late as possible and all succeeding activities started as early as possible.

I_F = Earliest finishing time
- Latest starting time
- Actual time of an Activity

$$I_F = EFT - LST - t_{ij}$$

Remark - It does not affect the float of preceding as well as Succeeding activities.

(iv) INTERFERING FLOAT (IT_F)

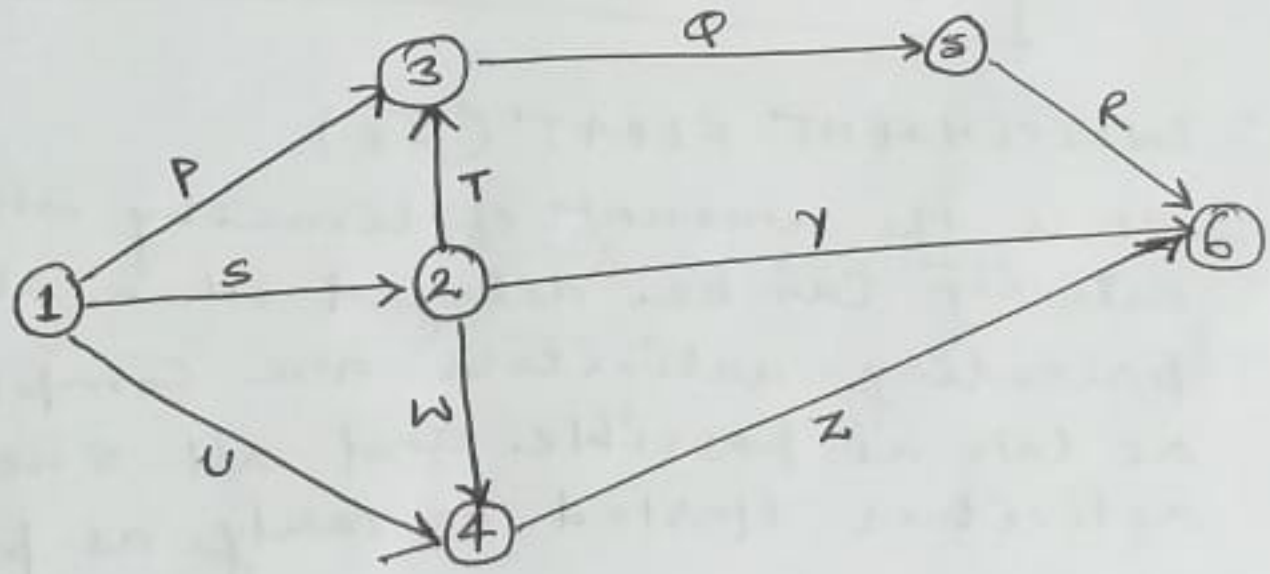
→ It is defined as difference of total float and free float of an activity.

→ It is also equal to slack of head event.

$$(IT_F) = (T.F) - (F.F)$$

Q.5. Solution :-

Network diagram



we know that-

Expected time, $t_e = \frac{t_o + 4t_m + t_p}{6}$

and standard deviation,

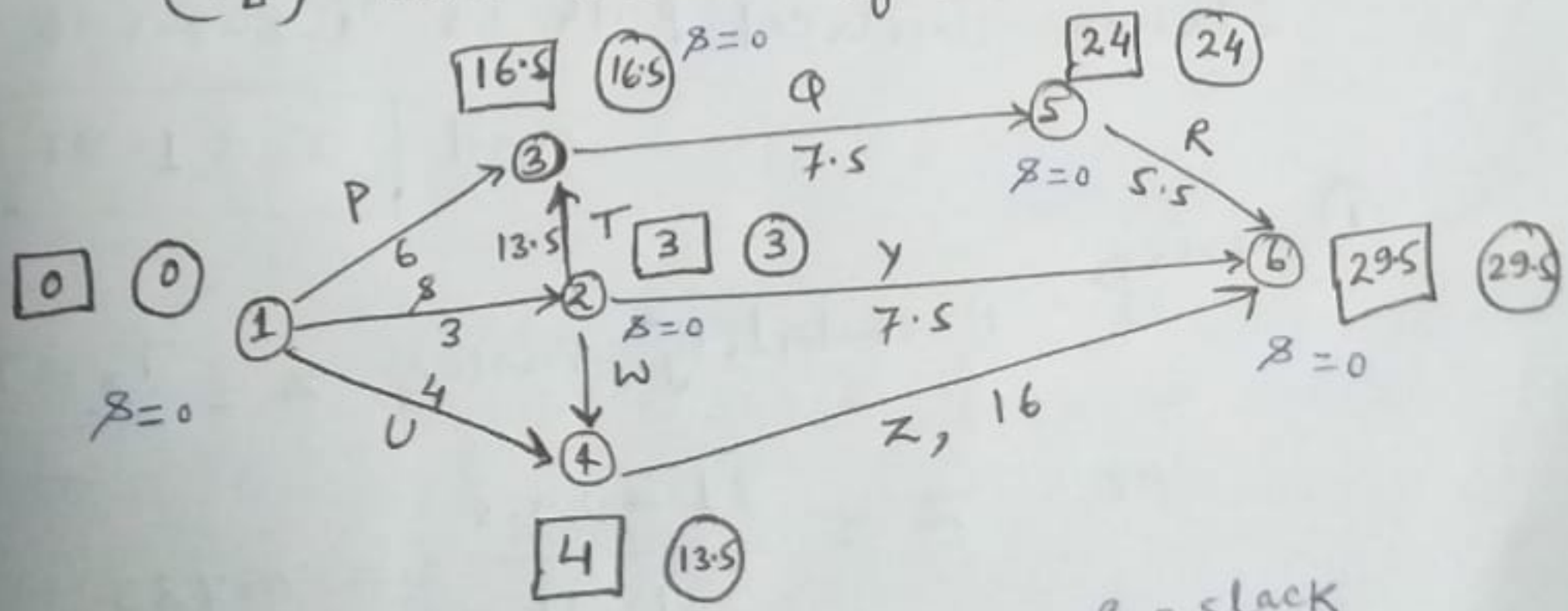
$$\sigma = \frac{t_p - t_o}{6}$$

Variance, $v = \sigma^2$

Using these formula we make a table given below :-

Activity	t_o	t_m	t_p	t_e	σ	v
P	3	6	9	6	1	1
Q	4	8	9	7.5	0.83	0.6889
R	4	5	9	5.5	0.83	0.6889
S	3	3	3	3	0	0
T	8	14	17	13.5	1.5	2.25
U	1	4	7	4	1	1
W	2	5	14	6	2	4
Y	4	7	13	7.5	1.5	2.25
Z	6	15	30	16	4	16

calculation of Earliest Expected Event occurrence time (T_E) and Latest allowable occurrence time (T_L) and slack of an event.



Here we have

$1-3-5-6$

and $1-2-3-5-6$ two option

but path having maximum variance is final critical path so,

σ along $1-3-5-6 = \sqrt{1+0.6889+0.6889}$

$$\boxed{\sigma_1 = \sqrt{2.3778}}$$

$\therefore$ variance $= \sigma^2 = 2.2778 = v_1$

σ along $1-2-3-5-6 = \sqrt{0^2+2.25+0.6889+0.6889}$

$$\boxed{\sigma_2 = \sqrt{3.6481}}$$

$\therefore$ variance $= \sigma_2^2 = 3.648 = v_2$

$\therefore$ $v_2 > v_1$

Hence Critical Path is $1-2-3-5-6$

and $\boxed{\sigma = 1.91}$

① using, Probability factor, $z = \dfrac{T_S - T_E}{\sigma}$

or $z = \dfrac{31-29.5}{1.91} = 0.785$

9f

Probability factor	Probability %
0.7	75.8
0.785	??
0.8	78.8

using interpolation:-

Probability % for $z = 0.785$

$$= 75.8 + \left(\frac{78.8 - 75.8}{0.8 - 0.7}\right)(0.785 - 0.7)$$

$$= 75.8 + 2.55$$

$$= 78.35\ \%$$

Hence Probability of Completion of Project in 32 days is 78.35%.

(21) For probability = 50%

we know that, Probability factor, $z = 0$

Hence, Completion time with 50% probability = 29.5 days.

Probability factor	Probability %
0.7	75.8
0.785	??
0.8	78.8

using interpolation:-

Probability % for $z = 0.785$

$$= 75.8 + \left(\frac{78.8 - 75.8}{0.8 - 0.7}\right)(0.785 - 0.7)$$

$$= 75.8 + 2.55$$

$$= 78.35\ \%$$

Hence Probability of completion of project in 31 days is 78.35%.

(21) For probability = 50%

we know that, probability factor, $z = 0$

Hence, completion time with 50% probability = 29.5 days