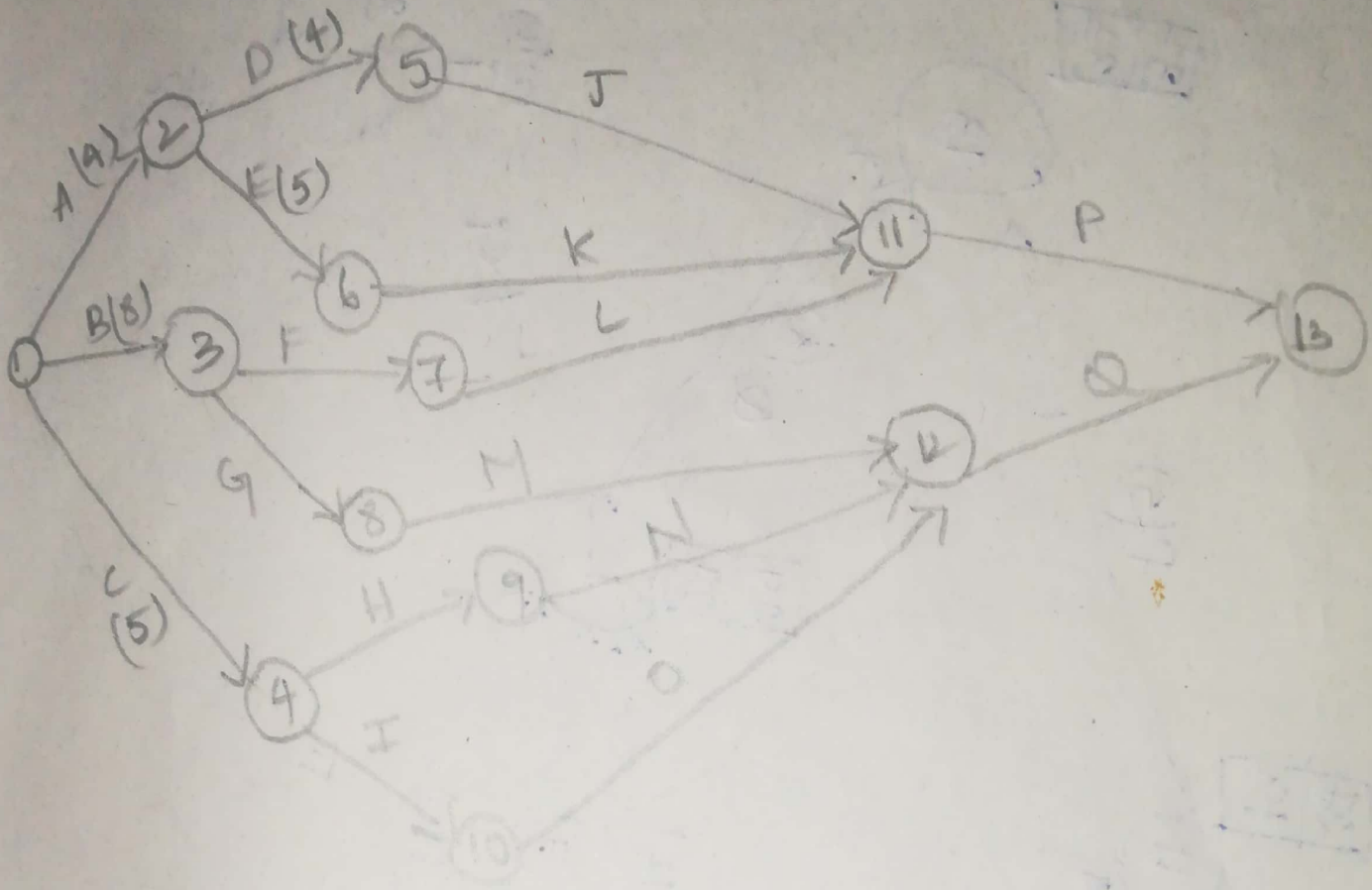
Consider the details of a project

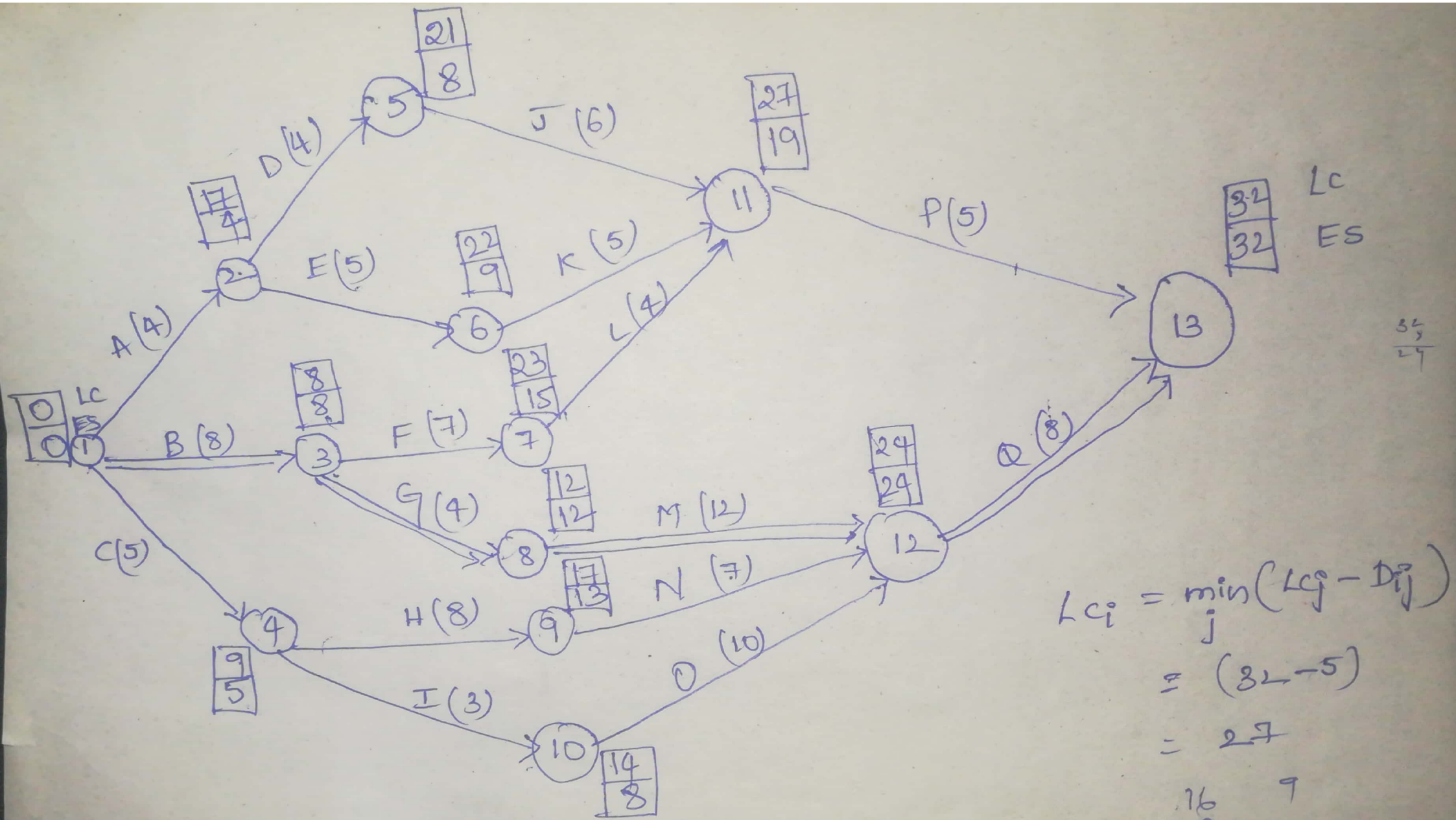
Activity	Immediate predecessor(s)	Duration (Months)
A	—	4
B	—	8
C	—	5
D	A	4
E	A	5
F	B	7
G	B	4
H	C	8
I	C	3
J	D	6
K	E	5
L	F	4
M	G	12
N	H	7
O	I	10
P	J, K, L	5
Q	M, N, O	8

→ ~~find out~~ construct the cpm network

→ Determine the critical path.

→ compute total floats and free floats for non-critical activities


A (9)
B (8)
C (5)
D (4)
E (5)
F
G
H
I
J
K
L
M
N
O
P
Q
1
2
3
4
5
6
7
8
9
10
11
12
13



$$Lc_i = \min_j (Lc_j - D_{ij})$$

$= (32 - 5)$

$= 27$

16 9

8

b) Critical path : 1-3-8-12-13
B-G-M-Q = 8+4+12+8 = 32

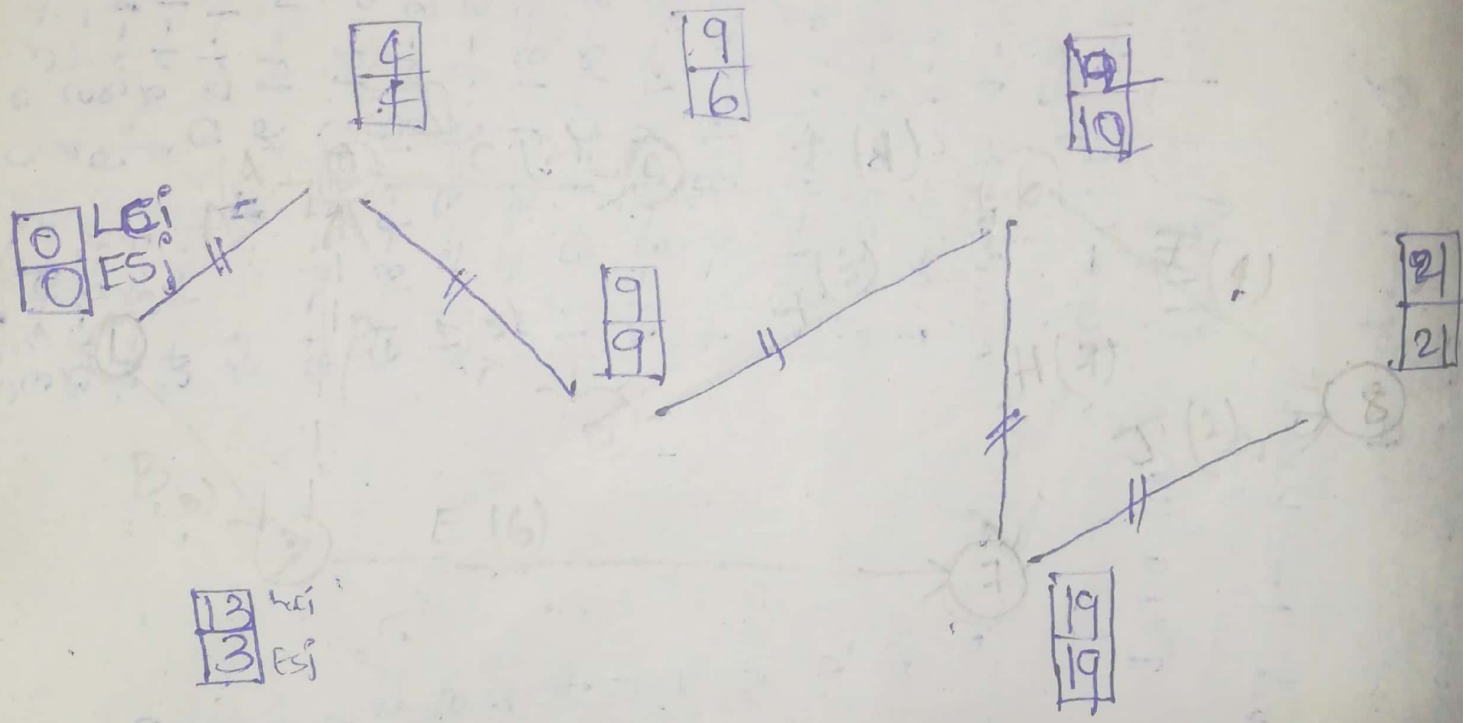
c) Total float and free float:

	Activity	Duration	(TFij) $LCj - ESi - Dij$	Free float (FFij) $ESj - ESi - Dij$
A	1-2	4	17-0-4=13	4-0-4=0
(B)	1-3	8	8-0-8=0	8-0-8=0
C	1-4	5	9-0-5=4	5-0-5=0
D	2-5	4	21-4-4=13	8-4-4=4
E	2-6	5	22-4-5=13	9-4-5=0
F	3-7	7	23-8-7=8	15-8-7=0
G	3-8	4	12-8-4=0	12-8-4=0
H	4-9	8	17-5-8=4	13-5-8=0
I	4-10	3	14-5-3=6	8-5-3=0
J	5-11	6	27-8-6=13	19-8-6=5
K	6-11	5	27-9-5=13	19-9-5=5
L	7-11	4	27-15-4=8	19-15-4=0
M	8-12	12	24-12-12=0	24-12-12=0
N	9-12	7	24-13-7=4	24-13-7=4
O	10-12	10	24-8-10=6	24-8-10=6
P	11-13	5	32-19-5=8	32-19-5=8
Q	12-13	8	32-24-8=0	32-24-8=0

CPM :(2) problem

21/12

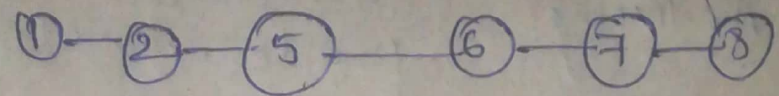
Activity	immediate predecessor(s)	Dur (week
A	—	4
B	—	3
C	A, B	2
D	A, B	5
E	B	6
F	C	4
G	D	3
H	F, G	7
I	F, G	4
J	E, H	2



$$ES_j = \left(ES_j + D_{ij}\right) \text{ Max.}$$

$$LC_i = \text{Min}\left(LC_i + D_{ij}\right)$$

critical path:



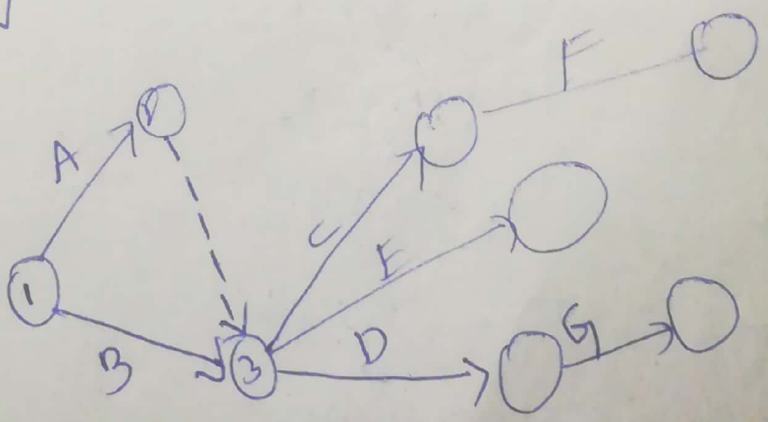
A — D — G — H — J

4 + 5 + 3 + 7 + 2 = 21 weeks

Non-critical Activity	free float (week) $E_{sj} - E_{si} - D_{ij}$	total float (week) $L_{cj} - E_{si} - D_{ij}$
1-3 B	3-0-3=0	13-0-3=10
2-4 C	9-4-2=2	9-4-2=3
3-7 E	19-13-6=10	19-13-6=0
4-6 F	12-6-4=2	12-6-4=2
~~6-7 H~~	~~19-12-12=0~~	
6-8 I	21-12-4=5	21-12-4=5

$L_{cj} - E_{si} - D_{ij}$ = 13-0-3=10

$E_{sj} - E_{si} - D_{ij}$ = 3-0-3=0



Activity	immediate predecessors (s)	Duration (Months)
A	—	5
B	—	2
C	A	3
D	C	4
E	C	2
F	B	4
G	D	7
H	E, F	6

$\left(\frac{9-1}{6}\right)^2 = \left(\frac{4}{3}\right)^2$

$\sigma^2 = \left(\frac{4}{3}\right)^2$

A — $\frac{a+4m+b}{6} = \frac{3+20+8}{6} = 24.3$

B — $\frac{6+28+9}{6} = 35.5$

C — $\frac{4+20+9}{6} = 25.5$

D — $\frac{3+20+8}{6} = 24.3$

E — $\frac{4+24+9}{6} = 29.5$

F — $\frac{5+32+11}{6} = 38.8$

G — $\frac{3+24+9}{6} = 28.5$

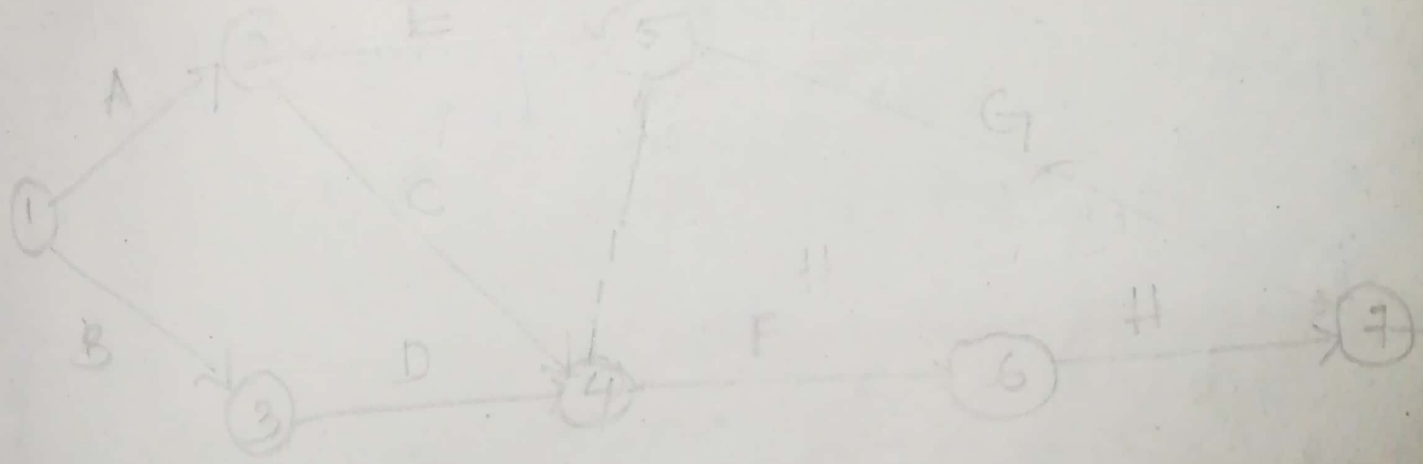
H — $\frac{1+36+9}{6} = 3 \;/\; 209.4$

Activity.

Consider the following data of a project

Activity	predecessor(s)	Duration (week)		
		a	m	b
A	—	3	5	8
B	—	6	7	9
C	A	4	5	9
D	B	3	5	8
E	A	4	6	9
F	C, D	5	8	11
G	C, D, E	3	6	9
H	F	1	2	9.

3+20+8



PERT-

Consider the following data of a project.

Activity	predecessor(s)	Duration (weeks)		
		a	m	b
A	—	3	5	8
B	—	6	7	9
C	A	4	5	9
D	B	3	5	8
E	A	4	6	9
F	C, D	5	8	11
G	C, D, E	3	6	9
H	F	1	2	9

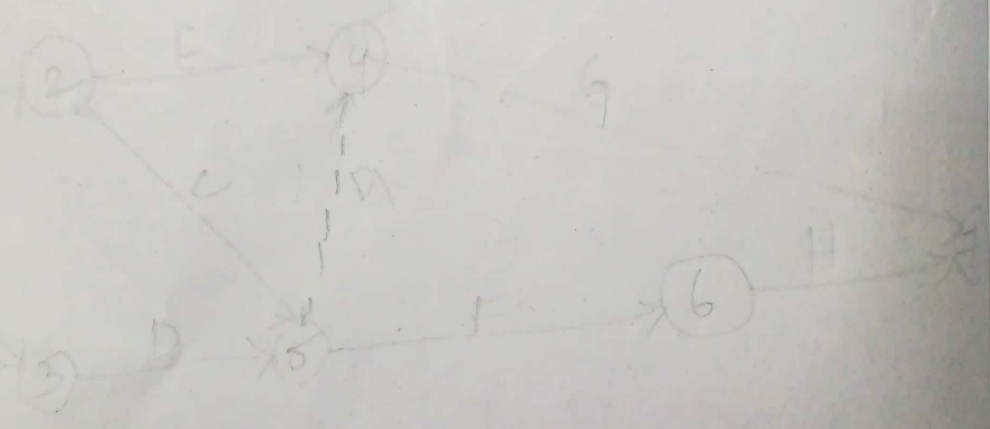
a) Construct project Network ?

b) find the expected duration and variance of each activity

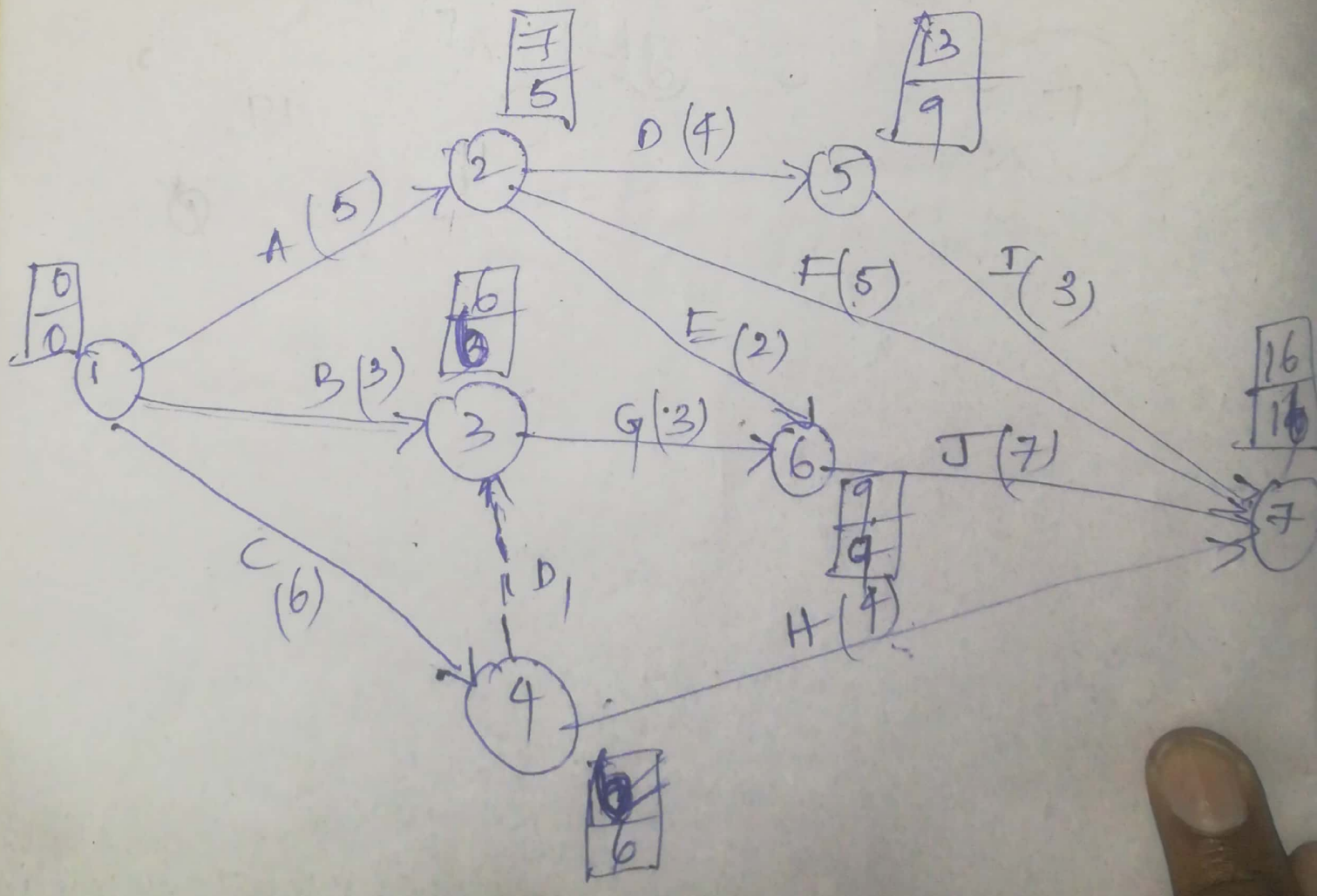
c) find the critical path and the expected project completion time.

d) what is probability of completing the project on or before 30 weeks ?

e) If the probability of completing the project is 0.9 find the



Activity	Immediate predecessor(s)	Duration a	m	b	Mean $\mu = \frac{a+4m+b}{6}$	Variance $\sigma^2 = \left(\frac{b-a}{6}\right)^2$
A	—	4	4	10	5	1·00
B	—	1	2	9	3	1·78
C	A	2	5	14	6	4·00
D	A	1	4	7	4	1·00
E	A	1	2	3	2	0·11
F	B, C	1	5	9	5	1·78
G	C	1	2	9	3	1·78
H	D	4	4	4	4	0·00
I	E, G	2	2	8	3	1·00
J	E, G	6	7	8	7	0·11



C.P ~~A-D-F-G-J~~ A-3-6-7

C-D-G-J ~~B-G-J~~ = ~~B+3+4~~

1-4,-3-6-7 =

Expected projected completion time is 16 weeks

(c) $p(x \leq c) = \left(\frac{x-\mu}{\sigma} \leq \frac{c-\mu}{\sigma}\right)$.

$p(x \leq 35) = \left(z \leq \frac{c-\mu}{\sigma}\right)$

$= \left(z \leq \frac{35-16}{5.89}\right)$

$= (z \leq 7.82)$

$= (z \leq$

Sum of all variance of critical activities

$\sigma = \sqrt{5.89}$ weeks

$\sigma = 2.42$

Sum of variace of critical activity =

$\sigma^2 = 4 + 1.78 + 0.11 = 5.89$

$\sigma = \sqrt{5.89} = 2.42$

$= \left(z \leq \frac{35-16}{2.42}\right)$

$p(x \leq 35) = (z \leq 7.851)$

$= 0.99.$

A project composed of 7 activities whose time estimates are as follows.

Activity	time in weeks t_o	t_m	t_p	mean	variance
1-2	1	1	7		
1-3	1	4	7		
1-4	2	4	18		
2-5	1	1	1		
3-5	2	5	14		
4-6	2	5	8		
5-6	3	6	15		

i) Draw PERT N-D

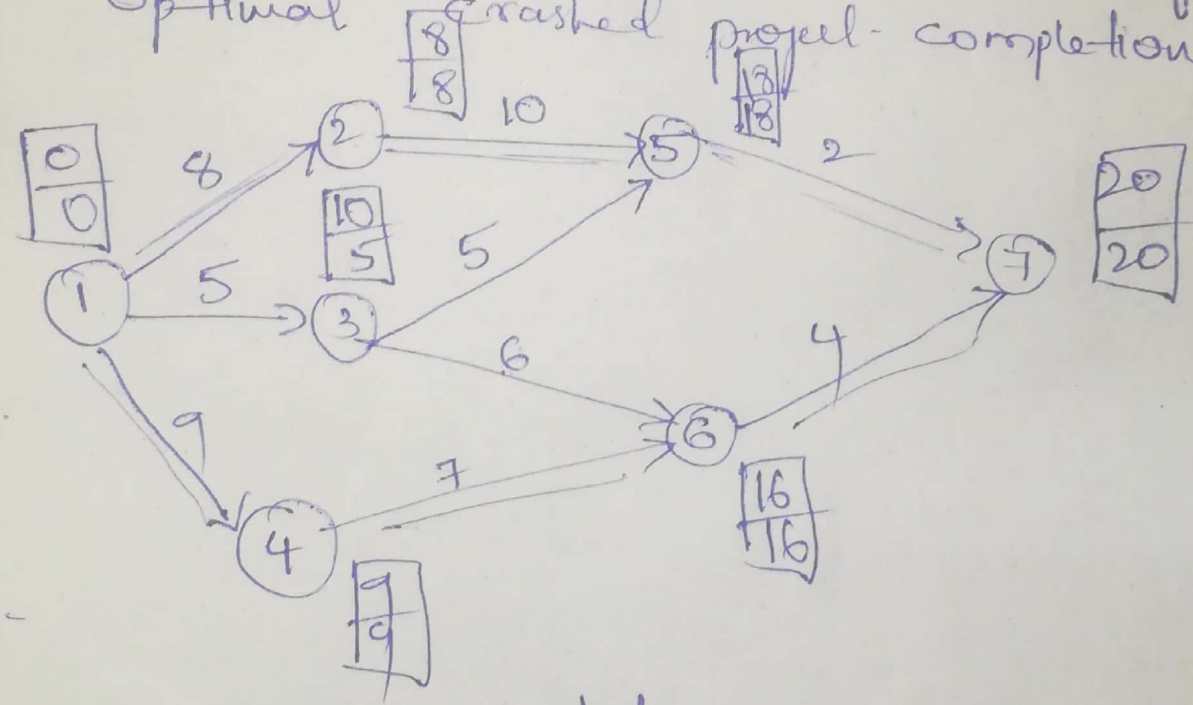
ii) Calculate stack of each event?

iii) Identify critical path.

iv) find the duration of project.

Activity	Normal time (t_n)	Normal cost (C_n) (Rs)	Crash time (t_c) weeks	Crash cost (C_c) (Rs)	Slope $\frac{C_c - C_n}{t_n - t_c}$
1-2	8	800	5	950	$\frac{150}{3} = 50$
1-3	5	500	3	700	$= 100$
1-4	9	600	6	1050	$\frac{450}{3} = 150$
2-5	10	900	8	1300	$\frac{400}{2} = 200$
3-5	5	700	3	1100	$\frac{400}{2} = 200$
3-6	6	1200	5	1500	$\frac{300}{1} = 300$
4-6	7	1300	5	1400	$\frac{100}{2} = 100$
5-7	2	400	1	500	$\frac{100}{1} = 100$
6-7	4	500	2	900	$\frac{400}{2} = 200$

If the indirect cost/week is Rs. 300 find the optimal crashed project completion time.



project complet = 20 weeks

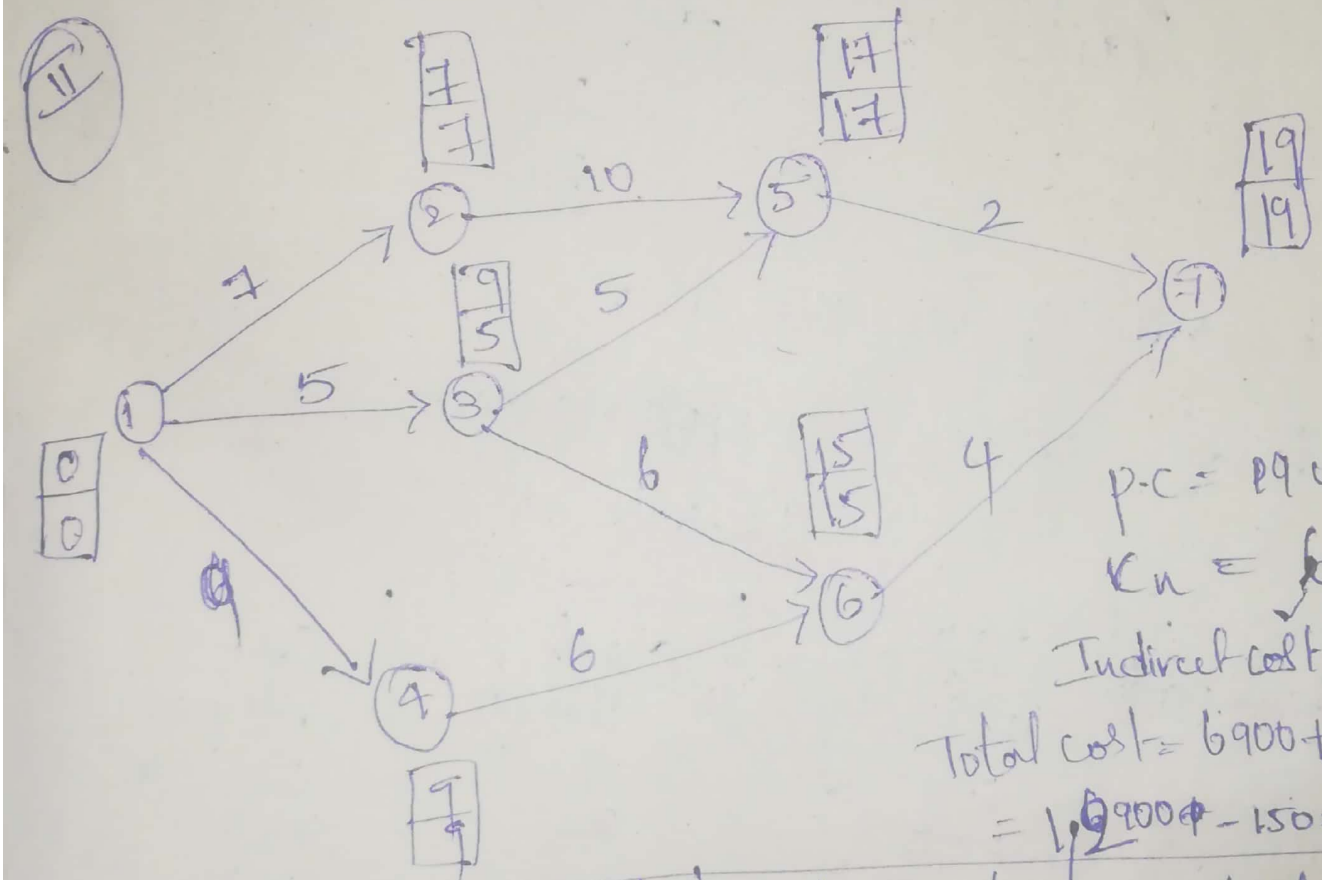
Normal cost = Rs 6,900

Indirect cost = 20 × 300 = 6000

Total cost = Rs. 12900

Critical path	Critical Activity	Crash limit $t_n - t_c$	Cost slope
1-2-5-7	1-2	~~3~~ 2	50 *
	2-5	2	200
	5-7	1	100
1-4-6-7	1-4	6	150
	4-6	~~5~~ 4	100 *
	6-7	2	200

1 2 900
1 700



P.C = 19 weeks

K_n = 6900

Indirect cost = 6000

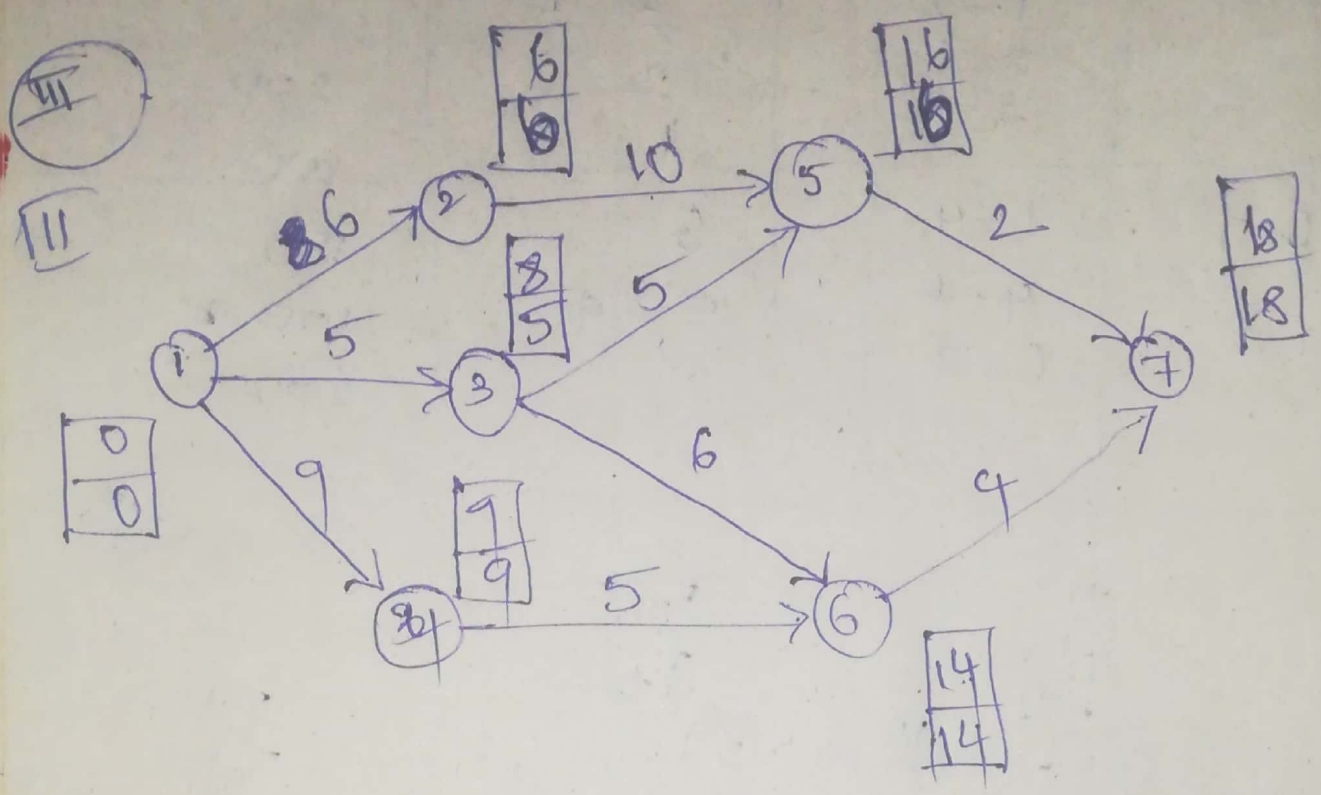
Total cost = 6900 + (50 + 100)

= 1,6900 - 150 = 6750 300

Critical path	Critical Activity	Crash limit	Cost slope
1-2-5-7	1-2	~~2~~ 1	50 *
	2-5	2	200
	5-7	1	100
1-4-6-7	1-4	6	150
	4-6	~~4~~ 3	100 *
	6-7	2	200

Total cost = 12900 + 150 - 300

= ~~13050 - 300~~ = 12750/-



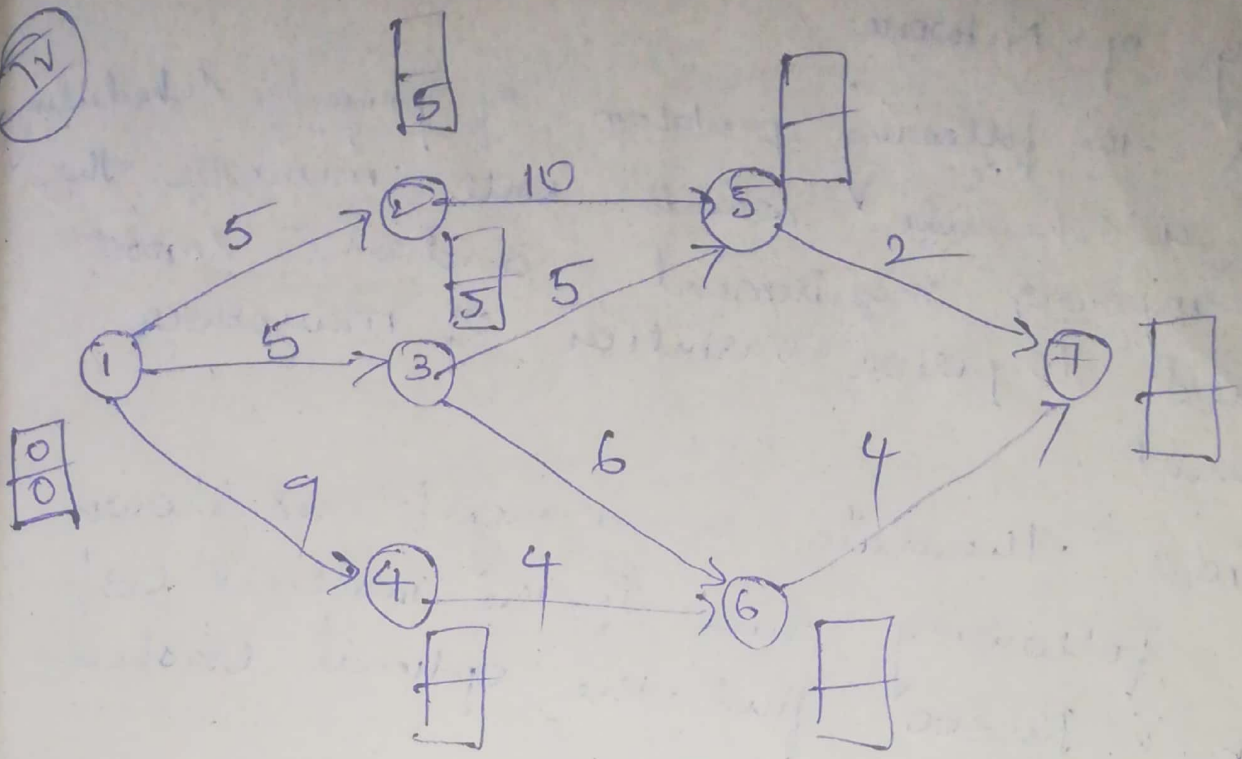
Total no. of weeks = 18 n

Total cost = 12750 + 150 - 300

= 12,600

Critical path	Critical activity	Crash limit	Cost slope
1-2-5-7	1-2	~~1~~ 0	50 *
	2-5	2	200
	5-7	1	100
1-4-6-7	1-4	6	150
	4-6	~~3~~ 2	100 *
	6-7	2	100

IV

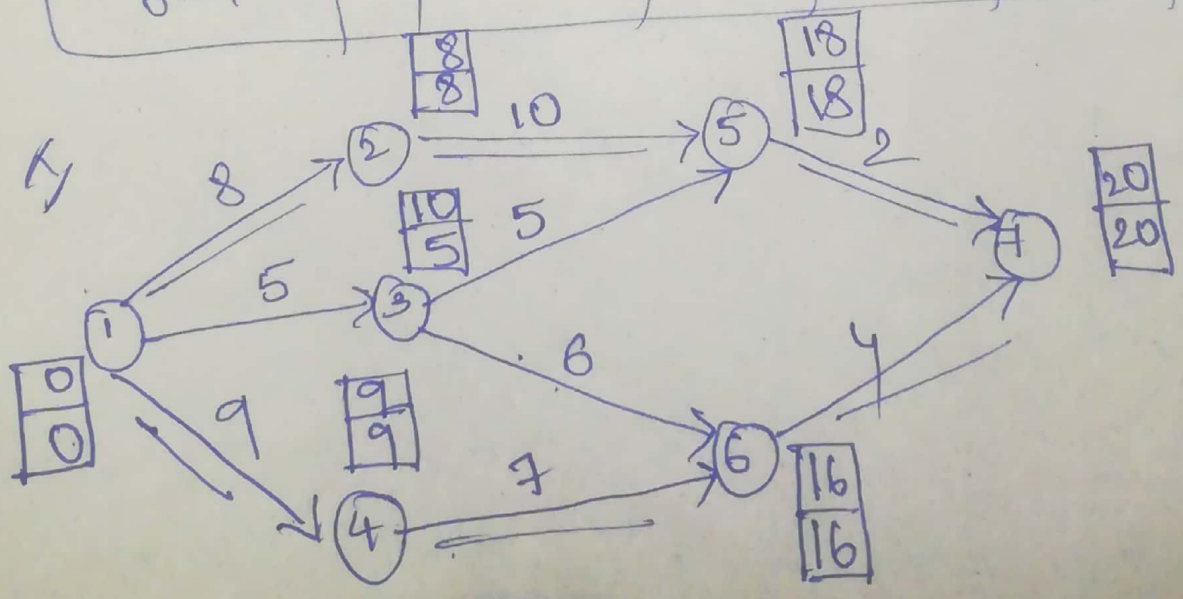


Crashing of Network

Consider the following problem of project scheduling obtain a schedule which will minimize the peak manpower requirement and also smooth out period to period variation of manpower requirement.

Consider the data of a project as shown in the following data if the indirect cost per week is Rs. 300. find the optimal crashed project completion time.

Activity	Normal time (weeks) (t_n)	Normal cost C_n (₹)	Crash time (weeks) t_c	Crash cost (C_c)	Slope (₹) $\frac{C_c - C_n}{t_n - t_c}$
1-2	8	800	5	950	50
1-3	5	500	3	700	100
1-4	9	600	6	1050	150
2-5	10	900	8	300	200
3-5	5	700	3	1100	200
3-6	6	1200	5	1500	300
4-6	7	1300	5	1400	100
5-7	2	400	1	500	100
6-7	4	500	2	900	200



The normal project completion time = 20 weeks

Critical path = 1-2-5-7
1-4-6-7

Total normal cost = 6900

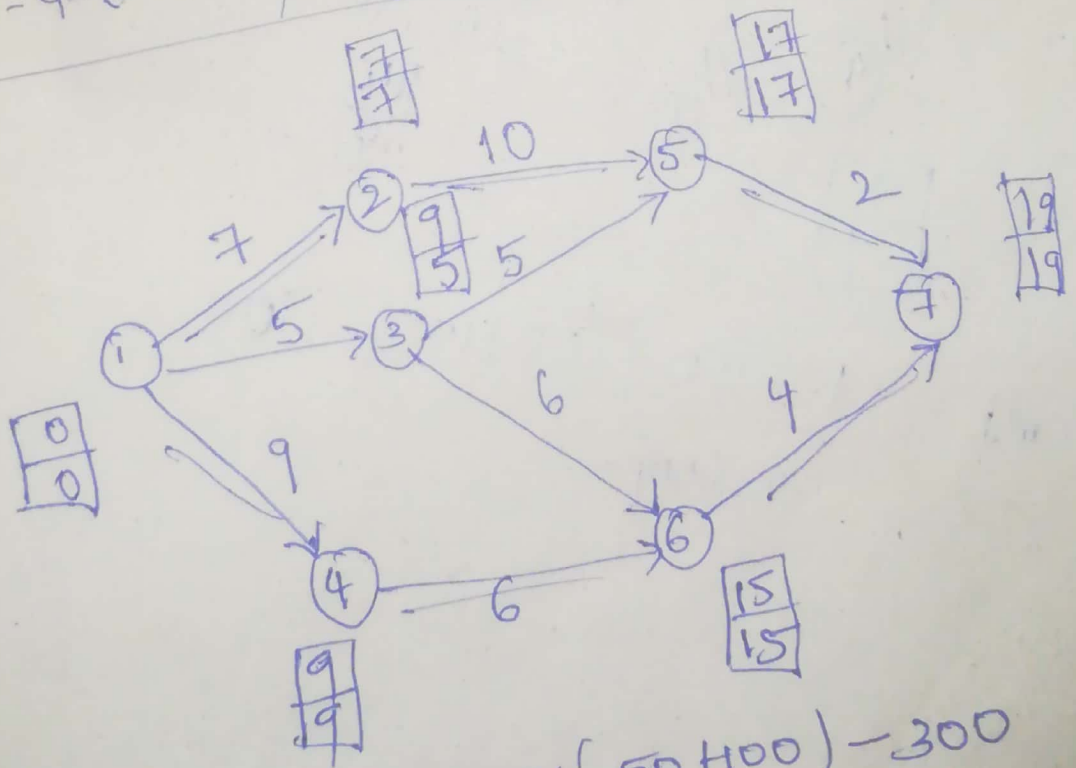
Indirect cost = (20 × 300) = 6000

total cost = 12,900

Crash limit and slope

Critical activity path	Critical activity	Crash limit	cost slope
1-2-5-7	1-2	3 2	50 *
	2-5	2	200
	5-7	1	100
1-4-6-7	1-4	3 2	150
	4-6	2 1	100 *
	6-7	2	200

II



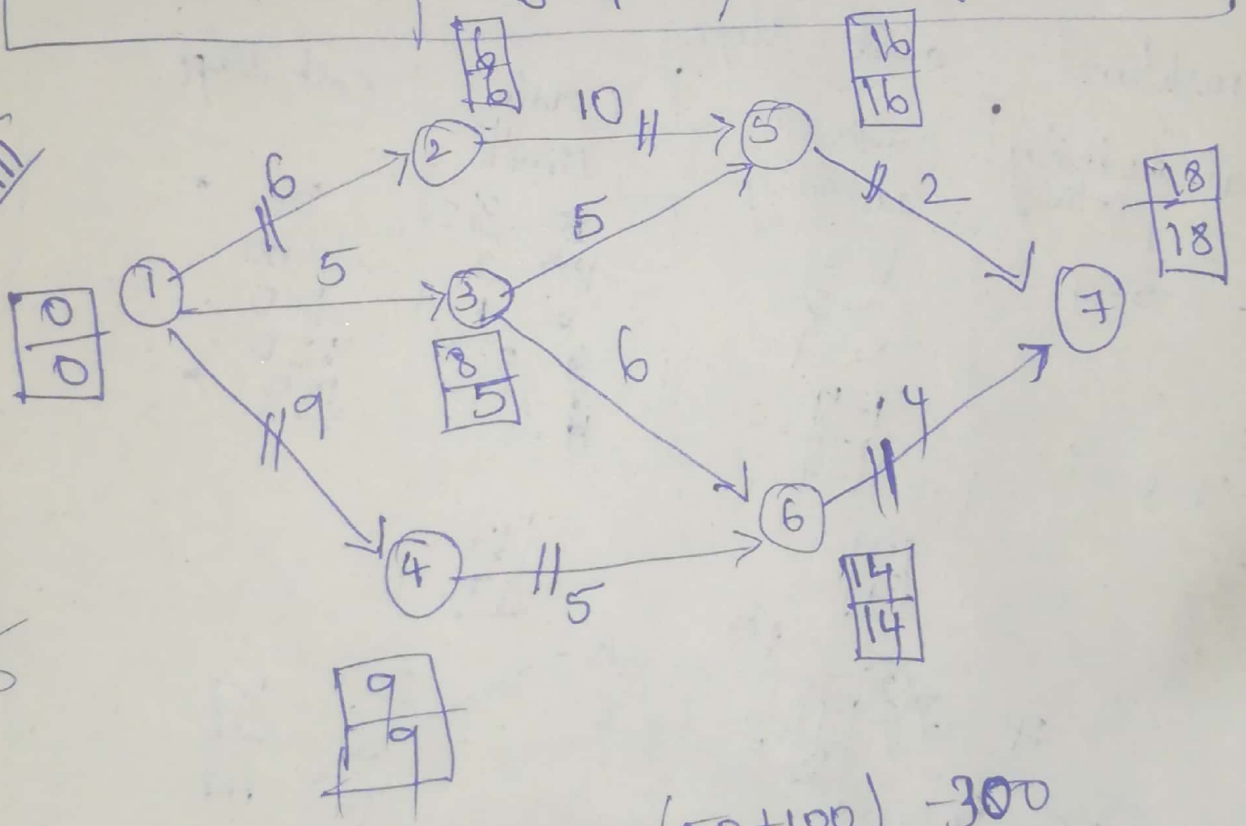
Total cost = 12,900 + (50 + 100) − 300

= 12,900 + 150 − 300

= 12,750/-

Critical Activity	Critical path	Crash Limit	Cost slope
1-2-5-7	1-2	✗ 1	50 *
	2-5	2	200
	5-7	1	100
1-4-6-7	1-4	2	150
	4-6	✗ 0	100 *
	6-7	2	200

III



14 + 8

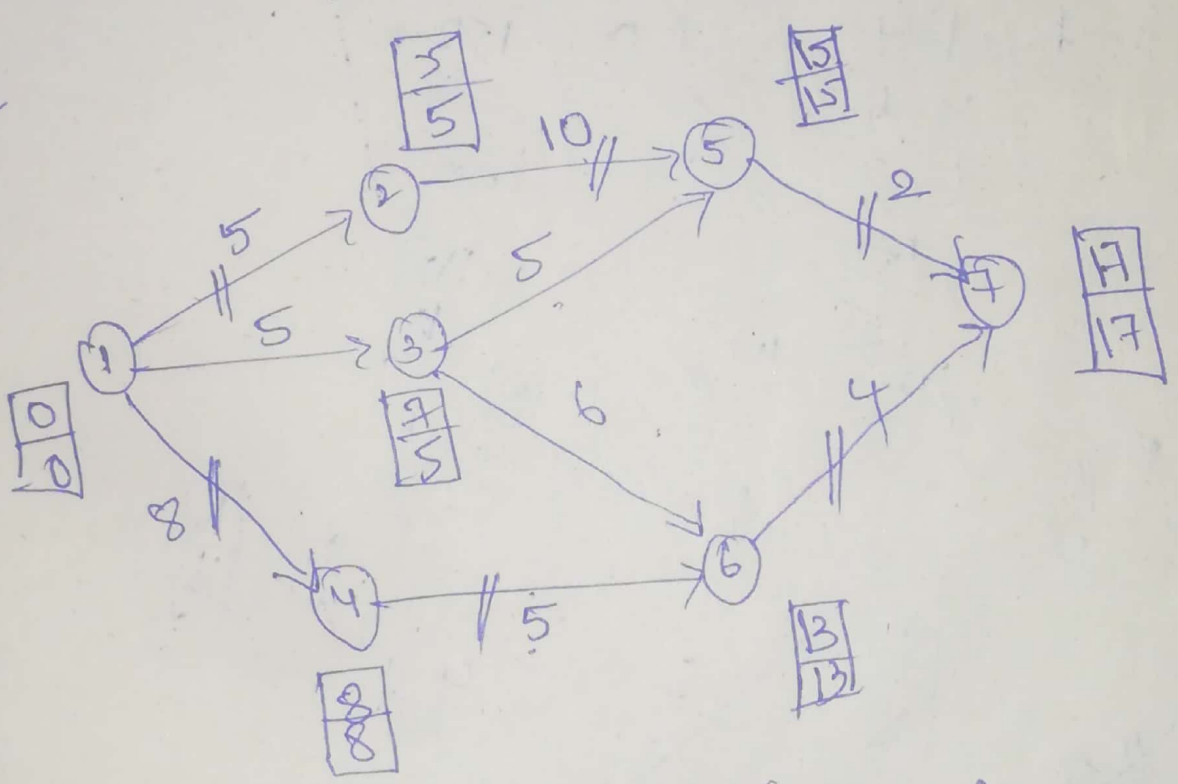
Total cost = 12,750 + (50+100) - 300

= 12,600/-

Critical Activity	Critical path	crash limit	Cost slope
1-2-5-7	1-2	~~0~~	50 *
	2-5	2	200
	5-7	1	100
1-4-6-7	1-4	~~2~~ 1	150 *
	4-6	0	—
	6-7	2	200

10

IV

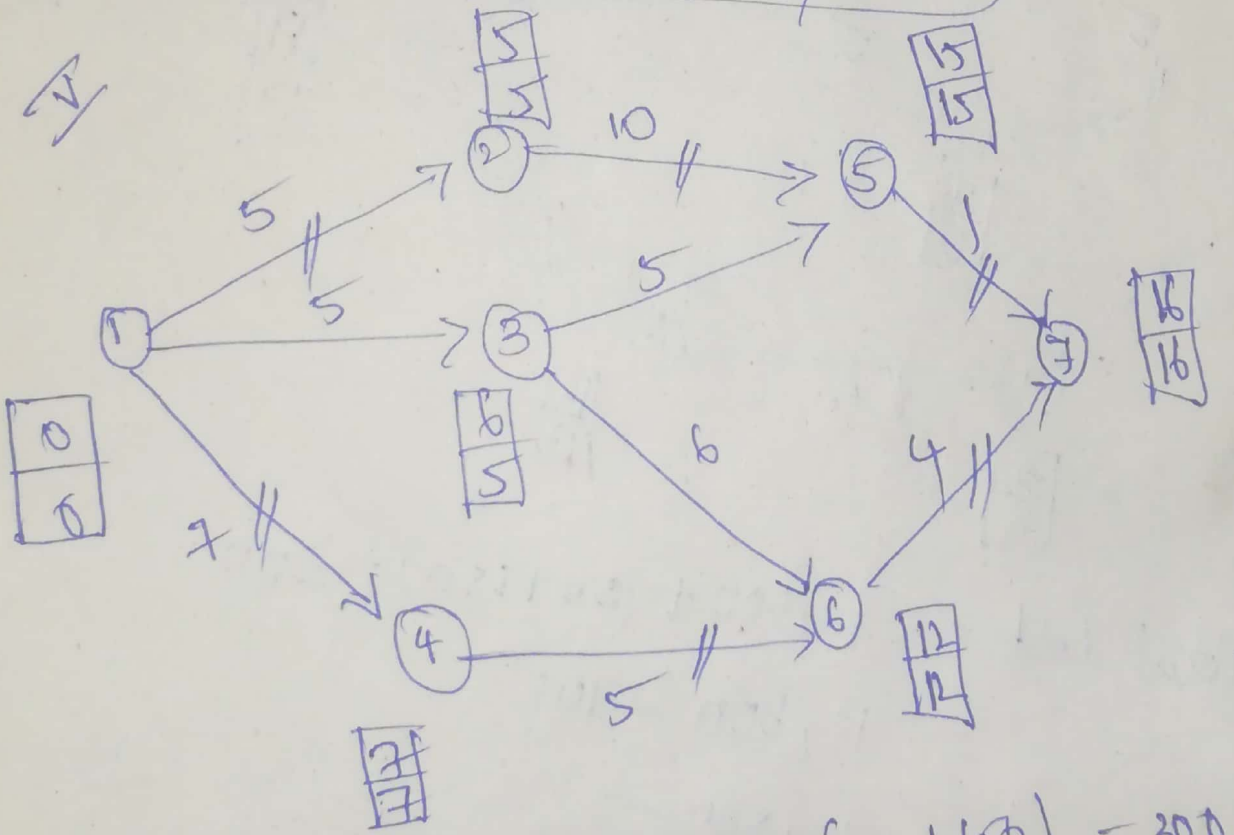


Total cost = 12,600 + (50 + 150) − 300

= 12,600 − 100

= 12,500/-

Critical activity	Critical path	Crash limit	Cost slope
1-2-5-7	1-2	0	—
	2-5	2	200
	5-7	1/0	100 ★
1-4-6-7	1-4	1/0	150 ★
	4-6	0	—
	6-7	2	200



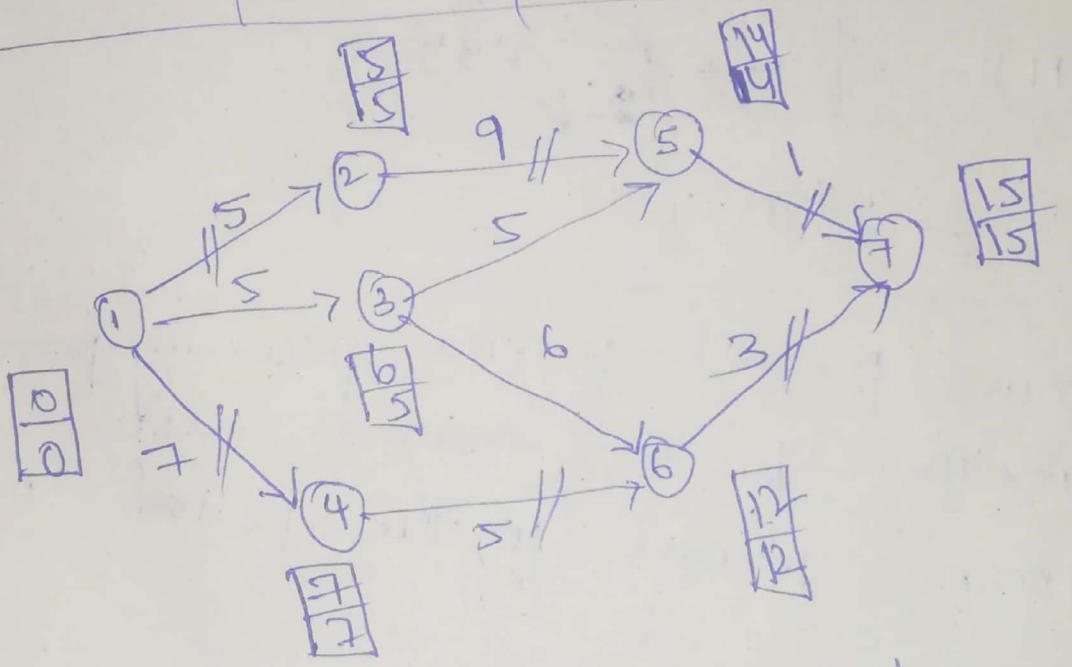
Total cost = 12,500 + (100 + 150) − 300

= 12,500 − 50

= 12,450/-

Critical activity	Critical path	Crash limit	cost slope
1-2-5-7	1-2	0	—
	2-5	2	200
	5-7	0	—
1-4-6-7	1-4	0	—
	4-6	0	—
	6-7	2	200

VI



Total cost = 12,450 + (200+200) − 300

= 12,400 + 100

= 12,500 /-

final projection completion time is = 16 weeks

critical path

i) 1-2-5-7

ii) 1-4-6-7