Assignment 3 OR

Ques 1)

M / J	A	B	C	D	E
M_1	6	8	7	10	6
M_2	3	2	5	6	4
M_3	4	8	6	7	8

$\min(M_1) = 6$
$\max(M_2) = 6$
$\min(M_3) = 4$

i) $\min(M_1) \geq \max(M_2)$ ✓
ii) $\min(M_3) \geq \max(M_2)$ ✗

} at least one condition satisfies so can be reduced to 2 machines G & H

$G_i = M_1 + M_2$, $H_i = M_2 + M_3$

M / J	A	B	C	D	E
G	9	10	12	16	10
H	7	10	11	13	12

Now applying Johnson's algorithm,
Optimal Job Sequence [E | D | C | B | A]

Minimum Elapsed Time

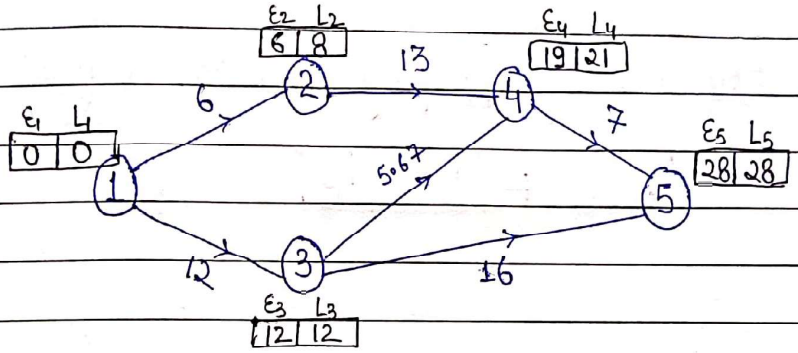
Job Sequence	Machine M_1		Machine M_2		Machine M_3	
	Time In	Time Out	Time In	Time Out	Time In	Time Out
E	0	6	6	10	10	14
D	6	16	16	22	22	29
C	16	23	23	28	29	35
B	23	31	31	33	35	43
A	31	37	37	40	43	47

Min. Elapsed time = 47 hours.
Idle time for M_1 = (47 − 37) = 10 hours
Idle time for M_2 = 6 + 6 + 1 + 3 + 4 + (47 − 40) = 27 hours
Idle time for M_3 = 10 + 4 + (47 − 47) = 14 hours

Ans

Ques 2)

Activity	to	tm	tp	Expected time (Duration) $\mu = t_e = \frac{t_o + 4t_m + t_p}{6}$	Variance $\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$
1-2	2	5	14	$(2+20+14)/6 = 6$	$(12/6)^2 = 4$
1-3	9	12	15	$(9+48+15)/6 = 12$	$(6/6)^2 = 1$ ✓
2-4	5	14	17	$(5+56+17)/6 = 13$	$(12/6)^2 = 4$
3-4	2	5	12	$(2+20+12)/6 = 5.67$	$(10/6)^2 = 2.78$
4-5	6	6	12	$(6+24+12)/6 = 7$	$(6/6)^2 = 1$
3-5	8	17	20	$(8+68+20)/6 = 16$	$(12/6)^2 = 4$ ✓



Zero slack values: $(|E_i - L_i| = 0) \Rightarrow 1, 3, 5$

Critical path $\Rightarrow$ 1-3-5

Expected project length = 12 + 16 = 28 days.

$\sigma^2 = 1 + 4 = 5$

$\sigma = \sqrt{5} = 2.24$

Scheduled project completion time = 30 days (X)

Expected time = 28 days (μ)

$$Z = P(X \leq 30) = \frac{X - \mu}{\sigma} = \frac{30 - 28}{2.24} = 0.89$$

When $Z = 0.89 \Rightarrow P = 0.8133 = 81.33\%$

Ans. Probability of meeting the scheduled time of 30 days = 81.33%.

Now, probability $P = 0.90$, then $Z = 1.28$

$Z(X \leq x) = 1.28$

$\frac{x - 28}{2.24} = 1.28 \Rightarrow$ **$x = 30.867$ days** Ans

Ques 3)

$M_i \backslash J \rightarrow$	A	B	C	D	E	F	G	H	I
M_1	4	7	6	11	8	10	9	7	6
M_2	8	10	9	6	5	11	5	10	13

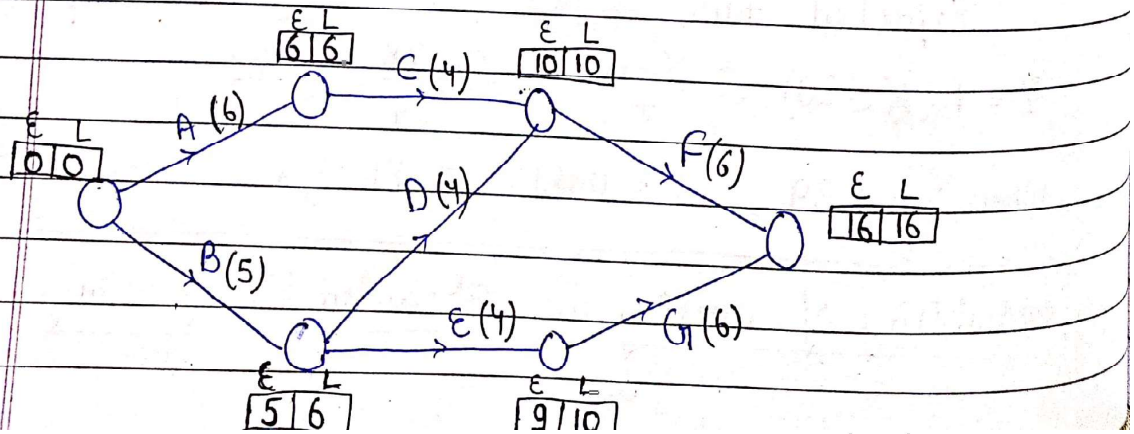
Job Sequence by applying Johnson's algorithm,

A	C	I	B	H	F	D	G	E

Ans

Ques 4)

Activity	t_o	t_m	t_p	$\mu = t_e = \frac{t_o + 4t_m + t_p}{6}$	Variance $\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$	SD σ
A ✓	3	6	9	$(3+24+9)/6 = 6$	$(6/6)^2 = 1$	1
B	2	5	8	$(2+20+8)/6 = 5$	$(6/6)^2 = 1$	1
C ✓	2	4	6	$(2+16+6)/6 = 4$	$(4/6)^2 = 0.44$	0.66
D	2	3	10	$(2+12+10)/6 = 4$	$(8/6)^2 = 1.78$	1.33
E	1	3	11	$(1+12+11)/6 = 4$	$(10/6)^2 = 2.78$	1.67
F ✓	4	6	8	$(4+24+8)/6 = 6$	$(4/6)^2 = 0.44$	0.66
G	1	5	15	$(1+20+15)/6 = 6$	$(14/6)^2 = 5.44$	2.33



Critical path → A - C - F
Expected project length = 6 + 4 + 6 = 16 weeks } Ans

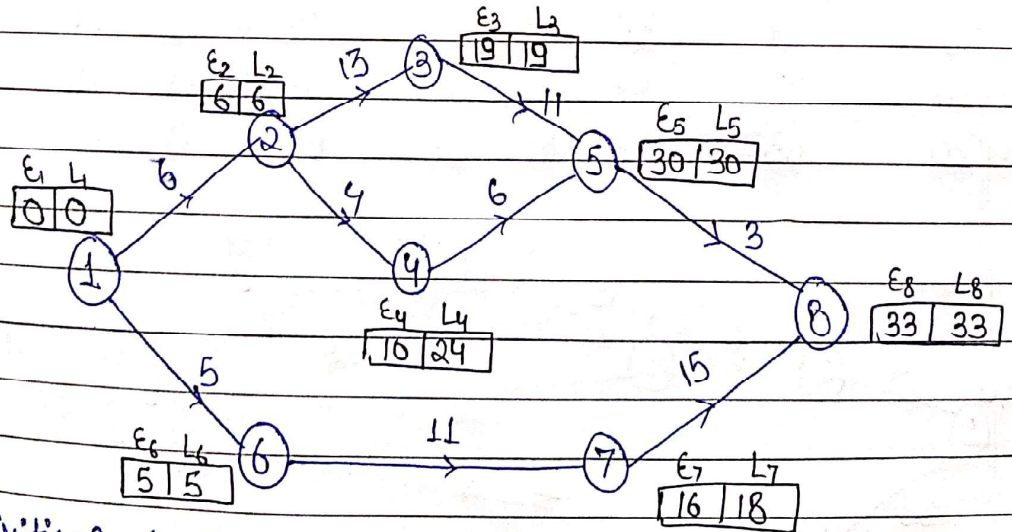
σ for critical path = $\sqrt{(1 + 0.44 + 0.44)} = 1.37$

$Z(X \leq 18) = \frac{X - \mu}{\sigma} = \frac{18 - 16}{1.37} = 1.46$

∴ Probability = 92.79% Ans

Ques 6)

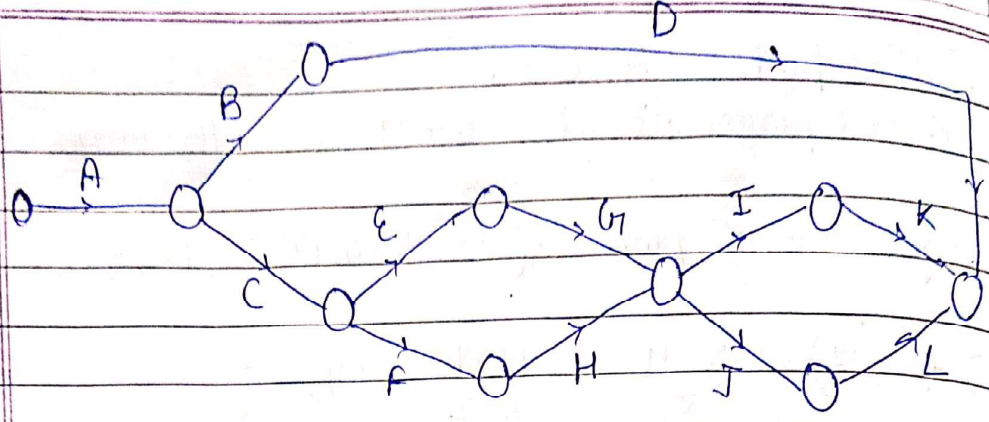
Activity	t_o	t_m	t_p	Expected time $\mu = t_e = \frac{t_o + 4t_m + t_p}{6}$	Variance $\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$
1-2	2	5	14	(2+20+14)/6 = 6	$(12/6)^2 = 4$
1-6	2	5	8	(2+20+8)/6 = 5	$(6/6)^2 = 1$
2-3	5	11	29	(5+44+29)/6 = 13	$(24/6)^2 = 16$
2-4	1	4	7	(1+16+7)/6 = 4	$(6/6)^2 = 1$
3-5	5	11	17	(5+44+17)/6 = 11	$(12/6)^2 = 4$
4-5	2	5	14	(2+20+14)/6 = 6	$(12/6)^2 = 4$
6-7	3	9	27	(3+36+27)/6 = 11	$(24/6)^2 = 16$
5-8	2	2	8	(2+8+8)/6 = 3	$(6/6)^2 = 1$
7-8	7	13	31	(7+52+31)/6 = 15	$(24/6)^2 = 16$



Critical path: 1 - 2 - 3 - 5 - 8
Project duration: 6 + 13 + 11 + 3 = 33 units } Ans

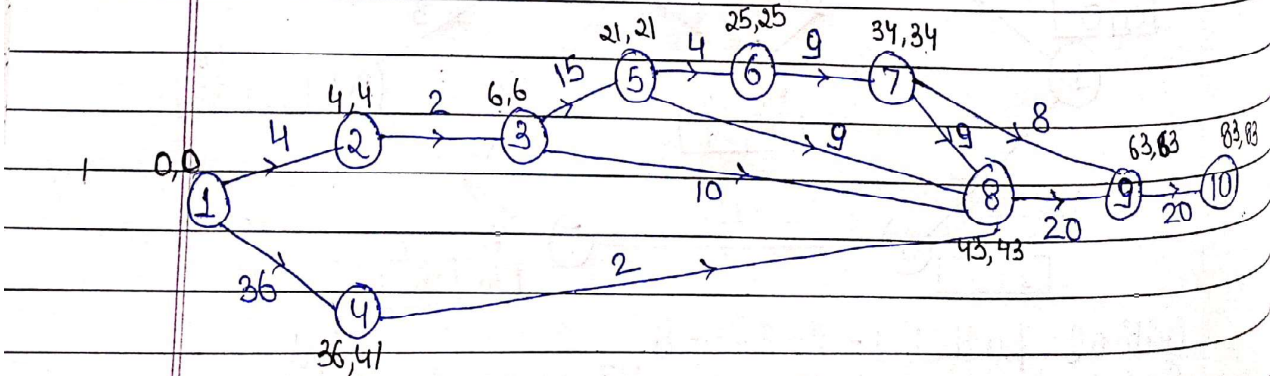
Date
Page

Ques 7)



Ques 8)

Activity	(Duration) Dij	Start: Earliest (Ei)	Start: Latest (Lj - Dij)	Finish: Earliest (Ei + Dij)	Finish: Latest (Lj)	Total Float Ti	Free Float Fi	Independent Float
1-2 ✓	4	0	0	4	4	0	0	0
1-4	36	0	5	36	41	0	5	0
2-3 ✓	2	4	4	6	6	0	0	0
3-5 ✓	15	6	6	21	21	0	0	0
3-8	10	6	33	43	43	27	27	27
4-8	2	36	41	43	43	5	5	0
5-6 ✓	4	21	21	25	25	0	0	0
5-8	9	21	34	43	43	13	13	13
6-7 ✓	9	25	25	34	34	0	0	0
7-8 ✓	9	34	34	43	43	0	0	0
7-9	8	34	35	63	42	1	21	21
8-9 ✓	20	43	43	63	63	0	0	0
9-10 ✓	20	63	63	83	83	0	0	0



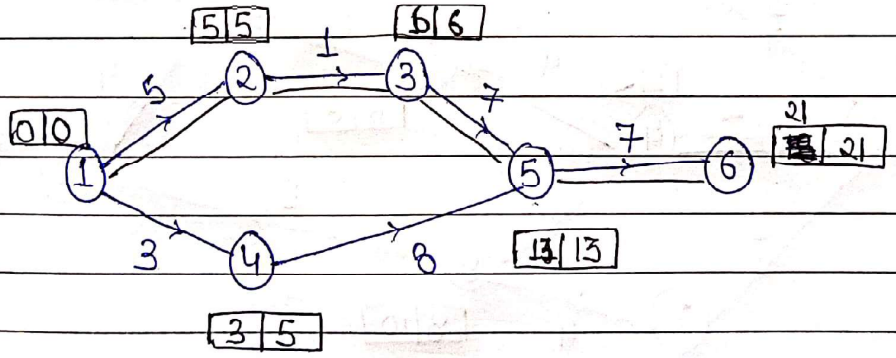
Critical path: 1-2-3-5-6-7-8-9-10

Total project duration = 4+2+15+4+9+9+20+20

Total float = $L_j - E_i - D_{ij}$	LST - EST or LFT - EFT
Free float = $E_j - E_i - D_{ij}$	
Independent float = $E_j - L_i - D_{ij}$	

Que 9)

Activity	t_o	t_m	t_p	$t_e = \frac{t_o + 4t_m + t_p}{6}$	Variance $\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$	SD σ
1-2	2	5	8	(2+20+8)/6 = 5	$(6/6)^2 = 1$	1
2-3	1	1	1	(1+4+1)/6 = 1	$(0/6)^2 = 0$	0
3-5	0	6	18	(0+36+18)/6 = 9	$(18/6)^2 = 9$	3
5-6	7	7	7	(7+28+7)/6 = 7	$(0/6)^2 = 0$	0
1-4	3	3	3	(3+12+3)/6 = 3	$(0/6)^2 = 0$	0
4-5	2	8	14	(2+32+14)/6 = 8	$(12/6)^2 = 4$	2



(Latest - Earliest) occurrence time of event

Activity	EST	LFT	Slack
1-2	0	5	0 ✓
2-3	5	6	0 ✓
3-5	6	13	0 ✓
5-6	13	21	0 ✓
1-4	0	5	0
4-5	3	13	2

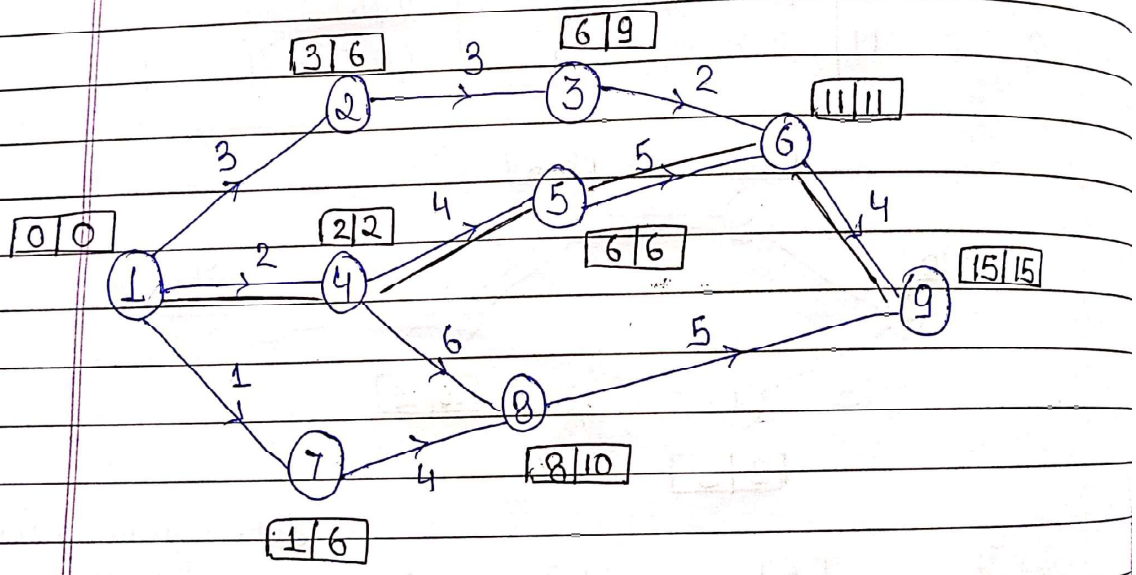
Critical Path: 1-2-3-5-6 Any

Date
Page

$E_i + D_{ij}$ ↑ $L_j - D_{ij}$ ↑ (L_j)

Que 10)

Activity	(Dij) Duration	(Ei) EST	EFT	LST	LFT	Ej	Li	TF	FF	Id.F
1-2	3	0	3	3	6	3	0	3	0	0
1-4 ✓	2	0	2	0	2	2	0	0	0	0
1-7	1	0	1	5	6	1	0	5	0	0
2-3	3	3	6	6	9	6	6	3	0	-3+6=3
3-6	2	6	8	9	11	11	9	3	3	0
4-5 ✓	4	2	6	2	6	6	2	0	0	0
4-8	6	2	8	4	10	8	2	2	0	0
5-6 ✓	5	6	11	6	11	11	6	0	0	0
6-9 ✓	4	11	15	11	15	15	11	0	0	0
7-8	4	1	5	6	10	8	6	5	3	-2+6=4
8-9	5	8	13	10	15	15	10	2	2	0



Critical path: 1 - 4 - 5 - 6 - 9

Duration total: 2 + 4 + 5 + 4 = (15)

TF = LST − EST or LFT − EFT

FF = $E_j - E_i - D_{ij}$

Id.F = $E_j - L_i - D_{ij}$