

JULY '18

A	M	T	W	F	S	S
1	2	3	4	5		
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

NPTEL

MONDAY

WK 29 DAY 197-168

16

WORKS TO DO

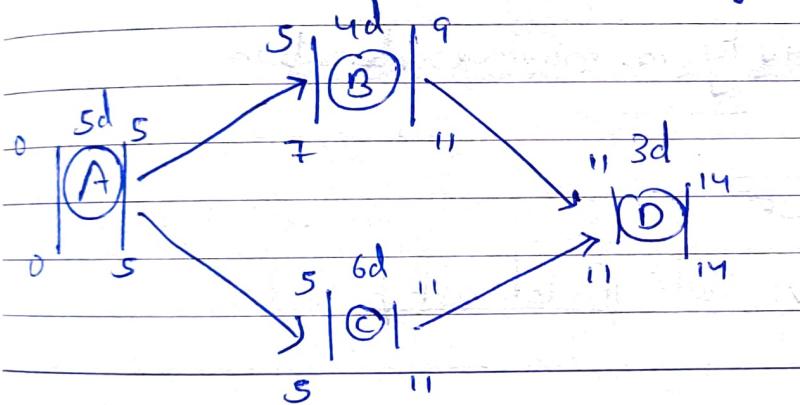
Crashing: Reducing duration of project by reducing duration of activity (Also called time cost tradeoff)

ABCD project

Current duration: 14 days

Expected duration: 10 days

Activity	Duration	Predecessor
A	5	-
B	4	A
C	6	A
D	3	B, C



TUESDAY

WK 29 DAY 198-167

17

Reduce duration of critical activities.

Fast-tracking: Trying to parallelise more things activities to reduce project duration

Crashing: Reducing duration of activities to reduce project duration.

Time-Cost Tradeoff is used to find the minimum overall project cost for a specified project duration.

JULY '18

18

WEDNESDAY

WK 29 DAY 199-166

M	T	W	T	F	S	S
30	31				1	
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
						'18

WORKS TO DO Crashing - Reducing activity time by expending additional resources.

(ND) Normal duration: Normal activity duration

(CD) Crash Duration: Minimum duration

(NC) Normal cost: cost of activity in normal duration

Normal duration

(CC) Crash cost: cost of activity in minimum duration

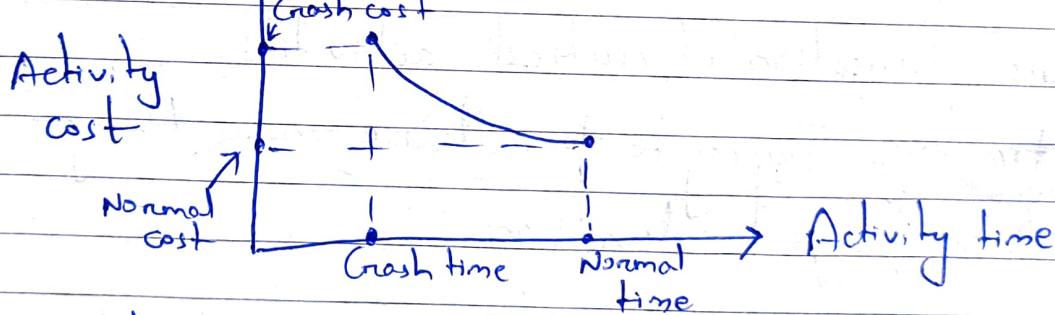
Duration  $\propto \frac{1}{\text{cost}}$

Activity: Time vs Cost Relationship

19

THURSDAY

WK 29 DAY 200-165



Slope: Increase in cost per unit time

A	M	T	W	F	S	S
18	1	2	3	4	5	
	8	9	10	11	12	
6	15	16	17	18	19	
13	22	23	24	25	26	
20	27	28	29	30	31	

Current days = 14  
Target = 10 days

JULY '18

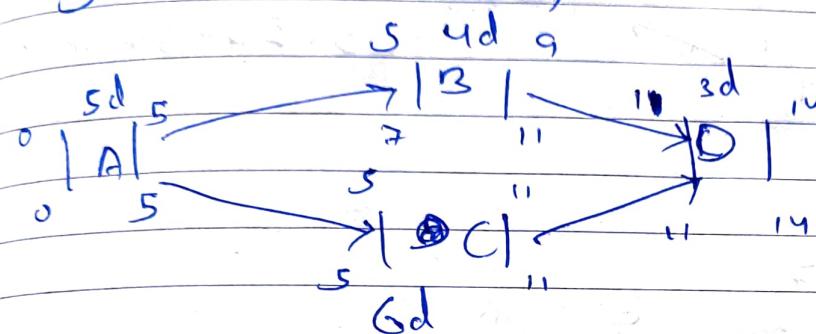
FRIDAY

WK 29 DAY 201-164

20

WORKS TO DO

Act	ND	Predecessor	CD	NC	CC
A	5	-	3	250	300
B	4	A	3	300	375
C	6	A	3	350	875
D	3	B,C	2	300	350



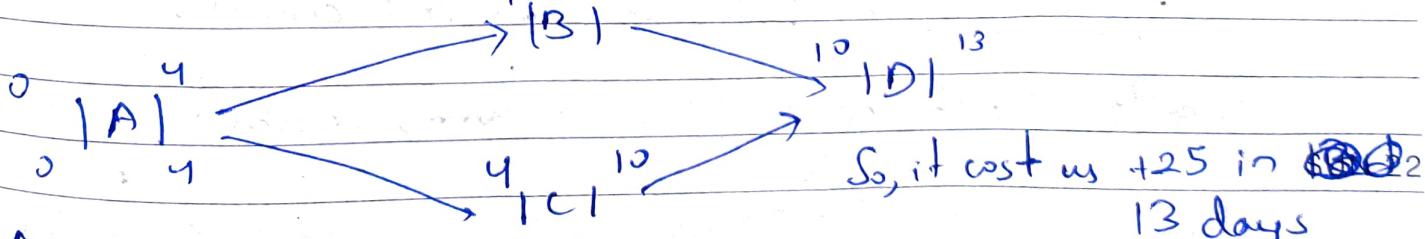
Initial approach: Crash those on critical path which have low crash cost.

Focus on A, C, D  
as B isn't on  
critical path

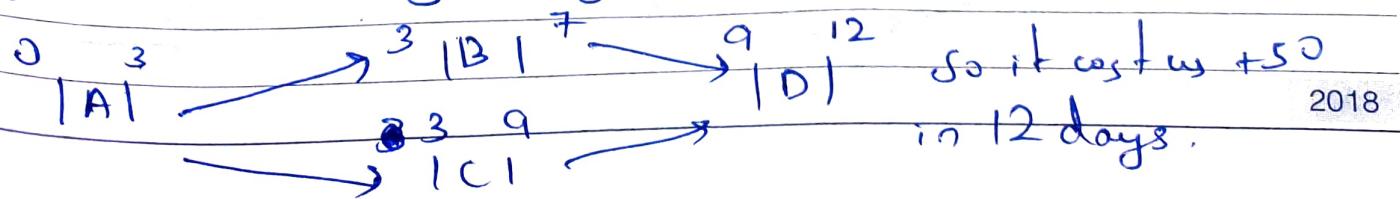
	Crash days	Crash cost/day	
A	2	25	
B	1	75	
C	3	175	
D	1	50	

SATURDAY  
WK 29 DAY 202-163 21

We first crash (A) by 1 day



Again crash (A) by 1 day



2018

JULY '18

23

MONDAY

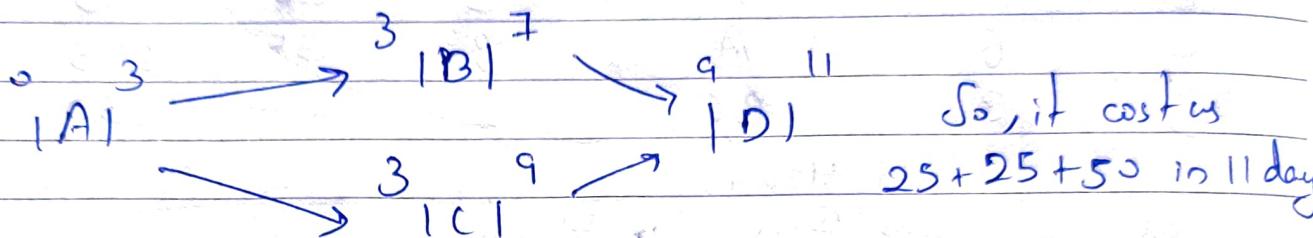
WK 30 DAY 204-161

M	T	W	T	F	S	S
30	31				1	J
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
						'18

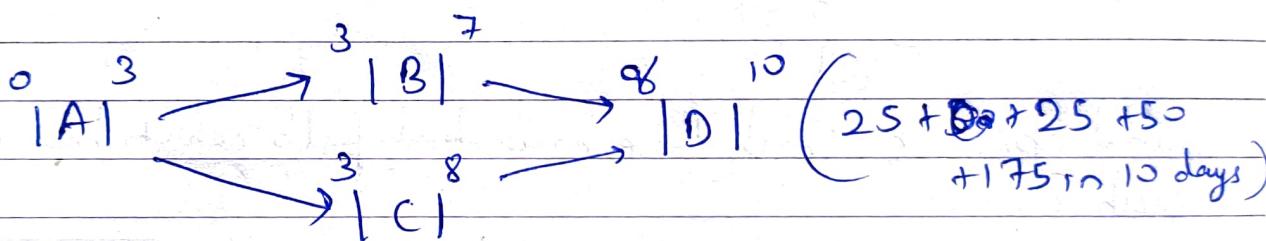
WORKS TO DO

A cannot be crashed anymore. (because CD for A = 3)

So, we choose to crash D.



Now, we crash C by 1



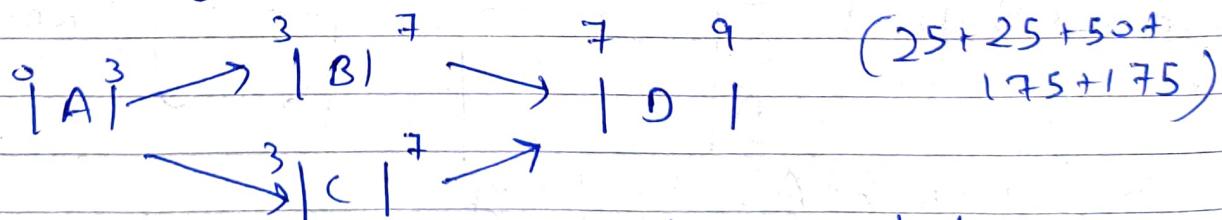
24

TUESDAY

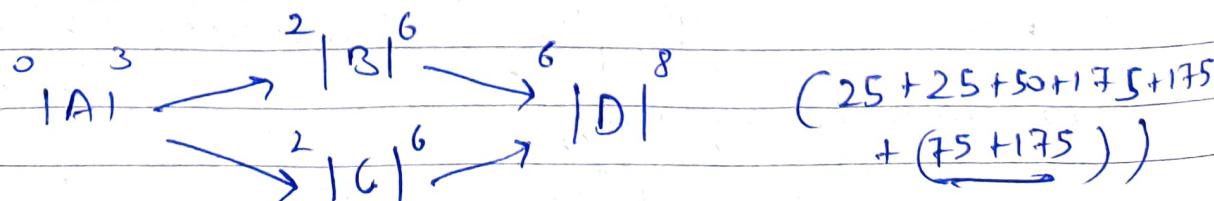
WK 30 DAY 205-160

Additional

Crash C by 1 more day



Now, B and C both have become critical.

So, ~~(B+C)~~ both have to be ~~removed~~ crashed

JULY '18

A	M	T	W	F	S	S
18	1	2	3	4	5	
	6	7	8	9	10	11
	13	14	15	16	17	18
	20	21	22	23	24	25
	27	28	29	30	31	

WEDNESDAY

WK 30 DAY 206-159

25

Each day addition      Cumulative Cost

WORKS TO DO

	3	1200 → Initial cost
14	+25	1225
13	+25	1250
12	+50	1300
11	+175	1475
10	+175	1650
9	+250	1900

Note: This is the envelope for minimum slope  
as we've taken activities with lowest costs

## Indirect Costs

### Project overhead:

- \* Staff, manager, project engineer salary
- \* Office equipment and utilities

THURSDAY

WK 30 DAY 207-158

26

### General overhead:

- \* Main office expenses - rent, maintenance
- \* Site equipment and vehicles
- \* Lawyers, accountants, advertisement, CSR
- \* Contingency fees: cost allocated for unknown events.

Rate per day is same, so it decreases with project duration.

DirectIndirect

Each day = 100

14	1200
13	1225
12	1250
11	1300
10	1475
9	1650
8	1900

1400	→ 2600
1300	→ 2525
1200	→ 2450
1100	→ 2400
1000	→ 2475
900	→ 2550
800	→ 2700

Optimum Value

2018

JULY '18

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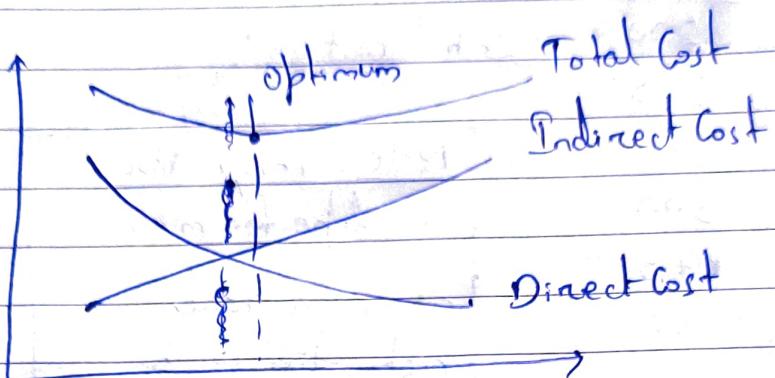
FRIDAY

WK 30 DAY 208-157

M	T	W	T	F	S	S	J
30	31						1
2	3	4	5	6	7	8	JUL
9	10	11	12	13	14	15	
16	17	18	19	20	21	22	
23	24	25	26	27	28	29	'18

WORKS TO DO

### Time-Cost Curve



Optimum occurs when the direct cost paid is less than the indirect cost saved. After that, the total cost starts increasing.

### Steps

28

SATURDAY

WK 30 DAY 209-156

- 1) Identify activities on Critical path
- 2) Compare unit cost of crashing (critical)

activities/combinations available for crashing. (Repeat steps until activity/combination cannot undergo further crashing)

- 3) Select activity/combination with minimum unit cost. In case of a tie, choose activity which influences more paths.

- 4) Reduce duration of activity/combination. (ensure no other path becomes critical if duration reduction is by more than 1 day)

- 5) Recalculate network parameters and go to step 1

	M	T	W	T	F	S
A	1	2	3	4	5	
U	6	7	8	9	10	11
G	13	14	15	16	17	18
'18	20	21	22	23	24	25
	27	28	29	30	31	

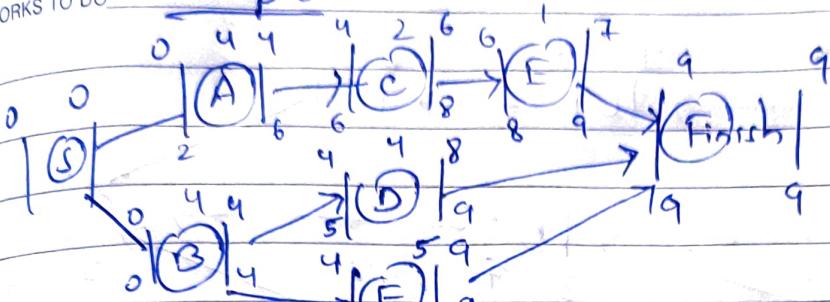
JULY '18

MONDAY

WK 31 DAY 211-154

30

WORKS TO DO

Example

Activity	ND	NC	CC	Slab (To be calculated)
A	4	3	100	125
B	4	3	250	400
C	2	1	150	150
D	4	1	450	900
E	1	0.5	200	400
F	5	2	200	50

Indirect cost = 125/day.

Develop least cost curve for project.

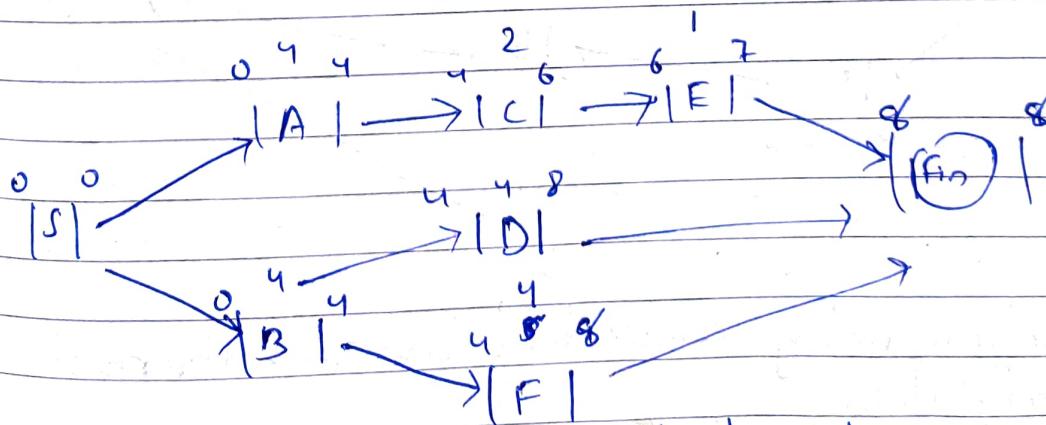
TUESDAY

WK 31 DAY 212-153

31

In above graph critical path = BF (9)

First, crash E (Cost = 50)



Then, crash both (D+F) as both have become critical or  
 ✓ just crash B. For B, cost = 150 ✓  
 (DFF), cost = 200

2018

AUGUST '18

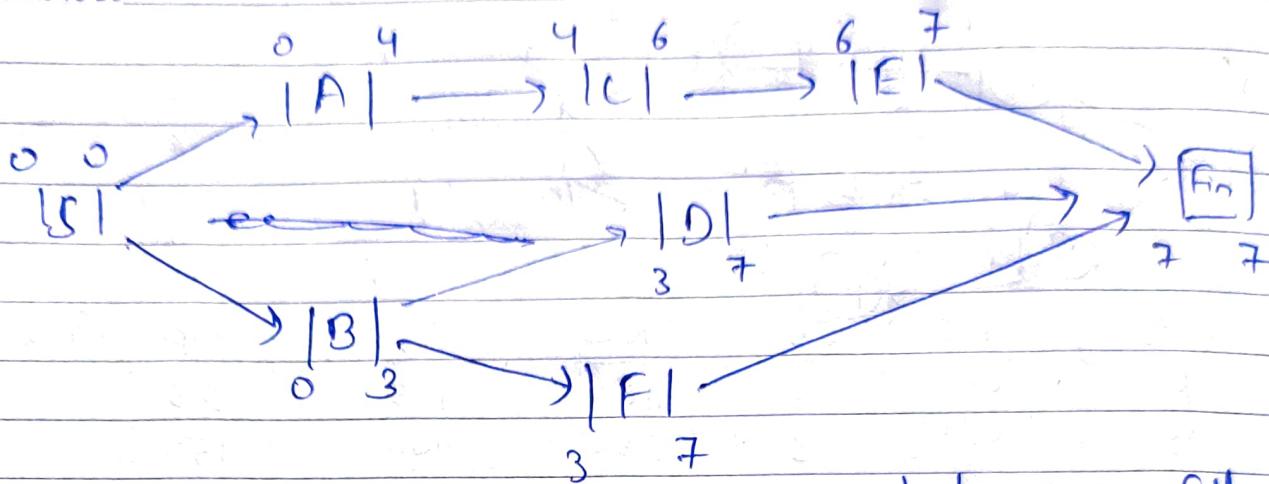
01

WEDNESDAY

WK 31 DAY 213-152

M	T	W	T	F	S	S
1	2	3	4	5		
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

WORKS TO DO



Now, ACE, BD, BF have become critical and B is fully crashed.

We have to do now crash combinations.

02

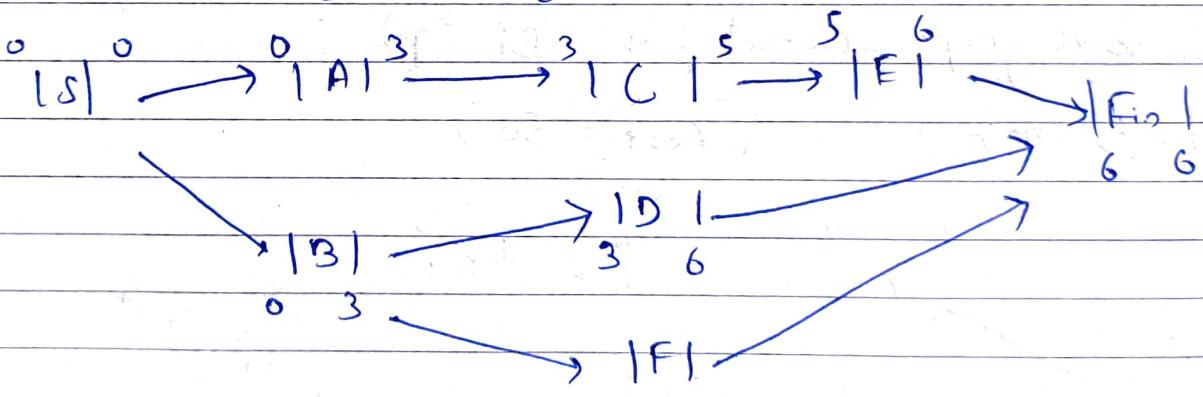
THURSDAY

WK 31 DAY 214-151

DFA → 225

DFC → 350

DFE → 600



Next:

1) Continue finding combinations and crash the most affordable.

2) Add indirect cost

3) Find Curve.

	M	T	W	T	F	S	S
S						1	2
E	3	4	5	6	7	8	9
P	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
18	24	25	26	27	28	29	30

AUGUST '18

FRIDAY

WK 31 DAY 215-150

03

WORKS TO DO

(New Example, New Format)

Activity	Path requiring time reduction			Cost slope	Available crash time (ND-CD)	Iteration				
	ABC	CFG	GHI			1	2	3	4	5
A	1	1	1							
B	1	1	1							
C	1	0	0							
D	0	1	0							
E	0	0	1							
F	1	0	0							
G	1	0	0							
H	0	1	0	1						

Initial Path length	Iteration	Action	Cost	Total Cost
	1		61	61
	2		216	216
	3		149	149
	4		216	216
	5		149	149
Path length				SUN 05

AUGUST '18

06

MONDAY

WK 32 DAY 218-147

M	T	W	T	F	S	S	
1	2	3	4	5	A		
6	7	8	9	10	11	12	U
13	14	15	16	17	18	19	G
20	21	22	23	24	25	26	
27	28	29	30	31			'18

~~WORKS TO DO~~Bonus & PenaltyQuestion

Activity	Preceded by	ND	CD	NC	CC	Cash days
A	-	120	100	12000	14000	20
✓B	-	20	15	1800	3800	5
C	B	40	30	16000	22000	10
✓D	C	30	20	1400	2000	10
✓E	D, F	50	40	3600	4800	10
F	B	60	45	13500	18000	15

07

TUESDAY

WK 32 DAY 219-146

Indirect cost = 400/day

Bonus/Penalty

↳ Normal duration 0

↳ Each excess day 300/day (Penalty)

↳ Each reduced day 300/day (Bonus)

Slope

- A → 100
- B → 400
- C → 600
- D → 60
- E → 120
- F → 300

S	M	T	W	T	F	S
E	3	4	5	6	7	8
P	10	11	12	13	14	15
'18	17	18	19	20	21	22
	24	25	26	27	28	29
	30					

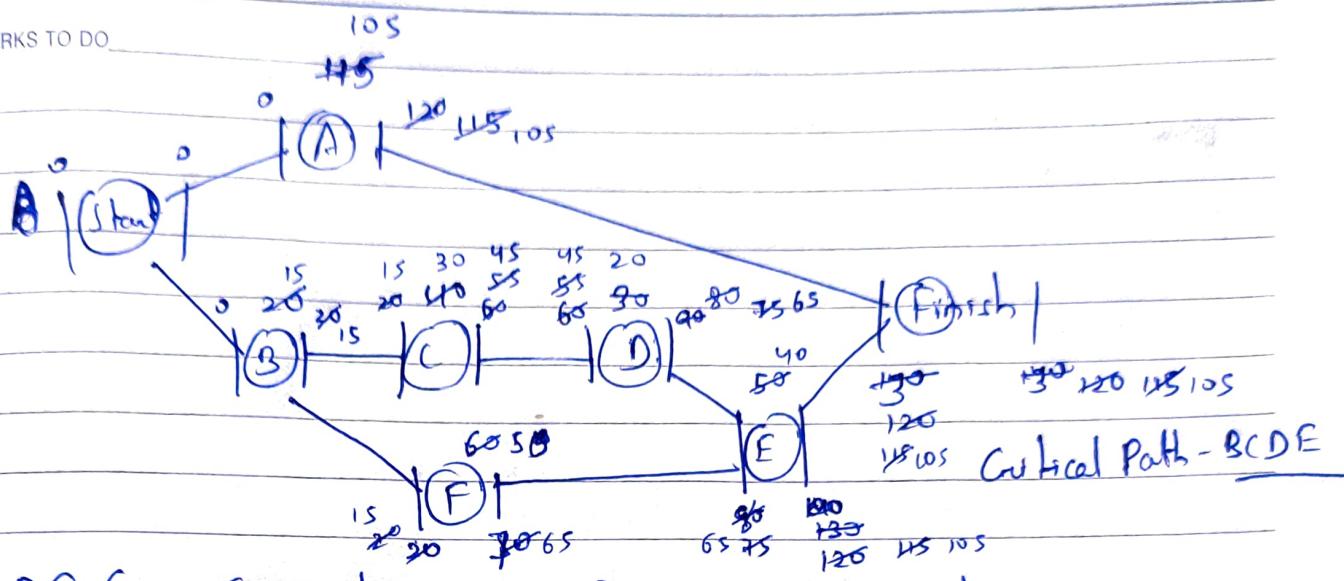
AUGUST '18

WEDNESDAY

WK 32 DAY 220-145

08

WORKS TO DO



(i) D@ 60 → 10 days (600) (D is fully crashed)

(ii) Combinations

B → 400

CF → 900

E → 120 ✓

THURSDAY

WK 32 DAY 221-144

09

E@ 120 for 10 days (1200) (E is fully crashed)

(iii) Combinations

AB → 500 ✓

ACF → 1000

AB@ 500 for 5 days (2500) (B is fully crashed)

(iv) ACF @ 1000 for 10 days (10000) (C is fully crashed)

(Then calculate direct, indirect, total cost) (Bonus/penalty not included)

(Add bonus for decreased days)