

Example 14.8 For a project consisting of several activities, the duration and required resources of carrying out each of the activities and their availabilities are given below.

Activities	Resources required		Duration (Days)
	Equipment	Operators	
1-2	X	30	4
1-3	Y	20	3
1-4	Z	20	6
2-4	X	30	4
2-5	Z	20	8
3-4	Y	20	4
3-5	Y	20	4
4-5	X	30	6

Resources Availability:

No. of operators = 50

Equipment X = 1

Equipment Y = 1

Equipment Z = 1

- (a) Draw the network, identify critical path and compute the total float for each of the activities.
 (b) Find the project completion time under the given resource constraints. (CA, November)

City

Pincode

State

District

Group

all letters.

Resource Allocation

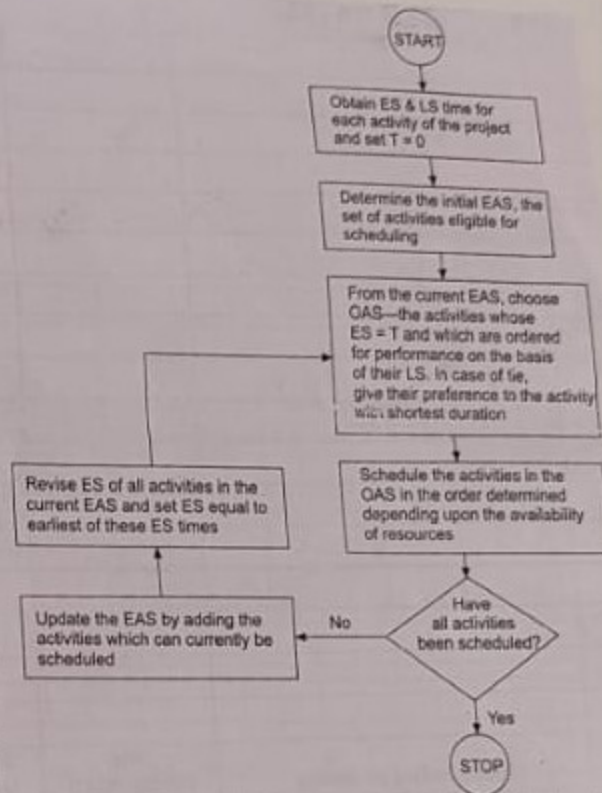
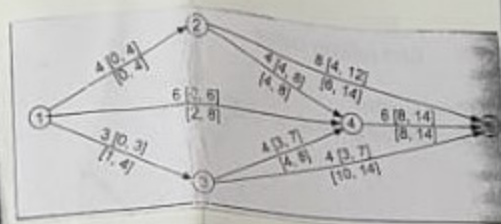


TABLE 14.5 ES and LS Times and Resource Requirements of Activities

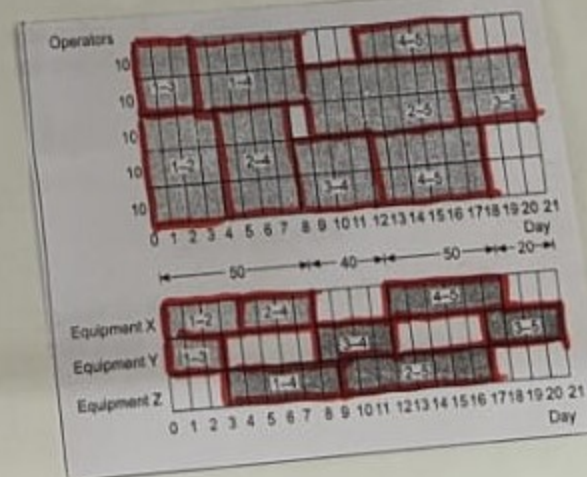
Activity	Duration	ES	LS	Float	Operators	Equipment
1-2	4	0	0	0	30	X
1-3	3	0	1	1	20	Y
1-4	6	0	2	2	20	Z
2-4	4	4	4	0	30	X
2-5	8	4	6	2	20	Z
3-4	4	3	4	1	20	Y
3-5	4	3	10	7	20	Y
4-5	6	8	8	0	30	X



- In case of tie minimum LS (for allocation)
- $ES = T$ (OAS group)
- $LS = (LC) - (\text{Duration})$ $EF = (ES) + (\text{duration})$
- critical path = 14 days \rightarrow add resource constraint to do more work

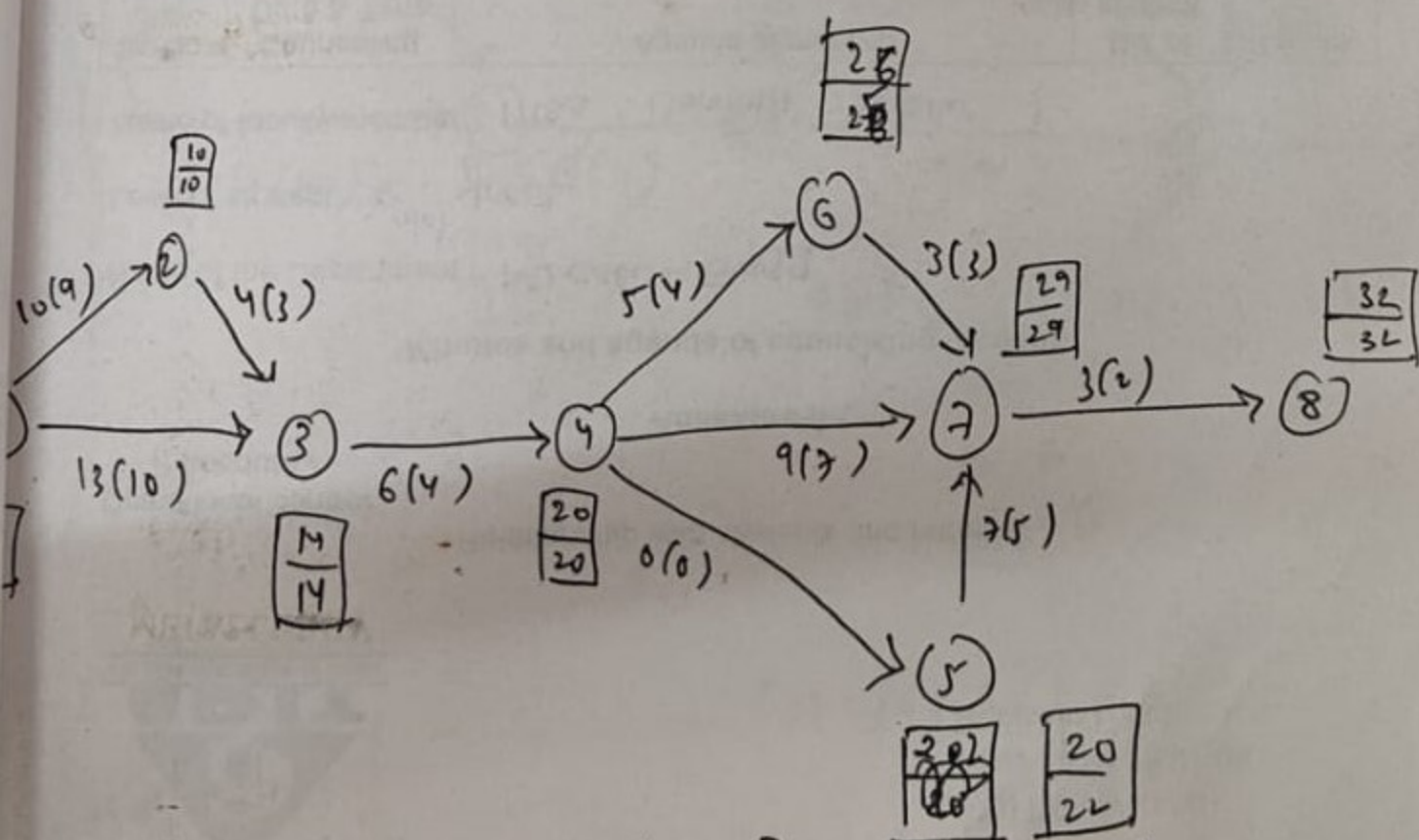
ES EF
LS LF

Halt 1	$T=0$						
EAS	1-2*	1-3*	1-4		2-4	2-5	3-4
ES	0	0	0				
LS	0	1	2				
OAS	1-2	1-3	1-4				
Schedule	1-2 for 4 days, Resources: 30 Persons and X; 1-3 for 3 days, Resources: 20 Persons and Y.						
Halt 2	$T=3$						
EAS	1-4*	2-4	2-5	3-4	3-5		
ES	3	4	4	3	3		
LS	2	4	6	4	10		
OAS	1-4	3-4	3-5				
Schedule	1-4 for 6 days, Resources: 20 Persons and Z.						
Halt 3	$T=4$						
EAS	2-4*	2-5	3-4	3-5			
ES	4	9	4	4			
LS	4	6	4	10			
OAS	2-4	3-4	3-5				
Schedule	2-4 for 4 days, Resources: 30 Persons and X.						
Halt 4	$T=8$						
EAS	2-5	3-4*	3-5	4-5			
ES	9	8	8				
LS	6	4	10				
OAS	3-4	3-5					
Schedule	3-4 for 4 days, Resources: 20 Persons and Y.						
Halt 5	$T=9$						
EAS	2-5*	3-5	4-5				
ES	9	12	12				
LS	6	10	8				
OAS	2-5						
Schedule	2-5 for 8 days, Resources: 20 Persons and Z.						
Halt 6	$T=12$						
EAS	3-5	4-5*					
ES	12	12					
LS	10	8					
OAS	4-5	3-5					
Schedule	4-5 for 6 days, Resources: 30 Persons and X.						
Halt 7	$T=17$						
EAS	3-5						
ES	17						
Schedule	3-5 for 4 days, Resources: 20 Persons and Y.						



	Normal	Normal	Crash	Crash	cost
	Duration	cost	duration	cost	slope (1)
-2	10	1000	9	1200	200
-3	13	780	10	900	40
-3	9	400	3	470	70
-4	6	320	4	410	45
1-5	0	0	0	0	0
1-6	5	250	4	300	50
4-7	9	720	7	810	45
5-7	7	420	5	580	80
6-7	3	30	3	30	0
7-8	3	300	2	400	100

Indirect cost Rs 50/day



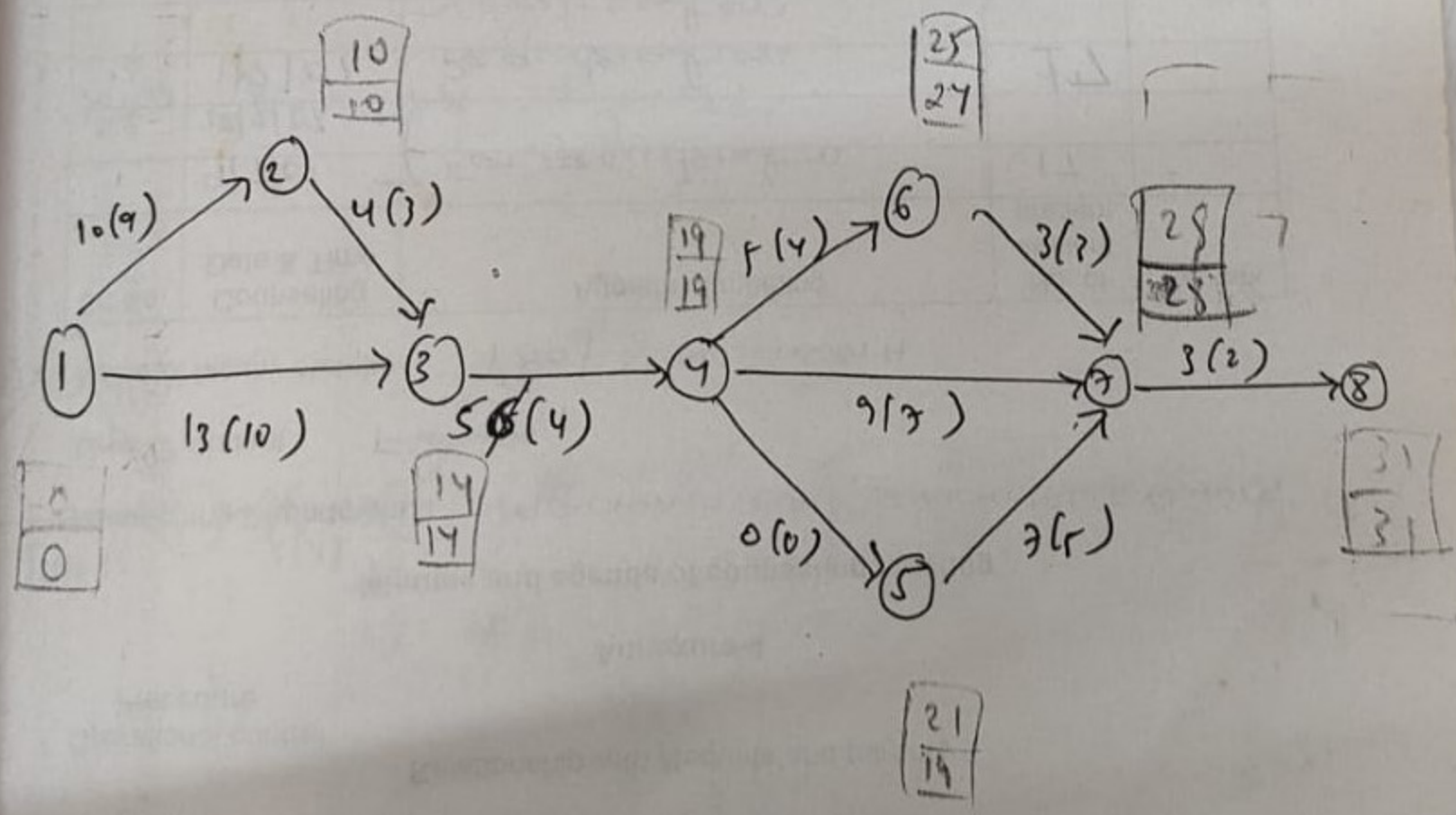
critical path - 1-2-3-4-7-8 (32 days)

Normal cost = DC + IDC

$$4220 + (18 \times 32) = 5820 \text{ (32 days)}$$

	C.S.
1-2	200
2-3	70
3-4	45 ✓
4-7	45
7-8	100

(Crash 3-4 by 1 week)

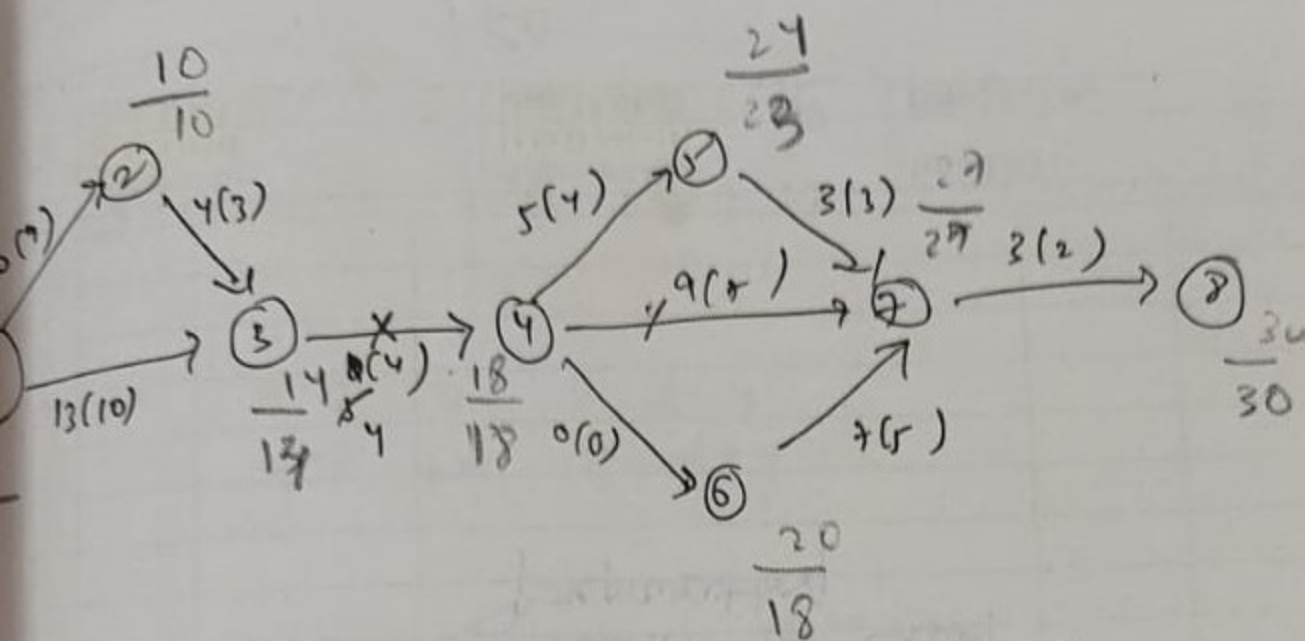


1-2 - 3-4 - 7-8 (31 days)

$$4220 + (1 \times 45) + (5.0 \times 31) = 5815 //$$

Cram 3-4 by 1 week

(3)

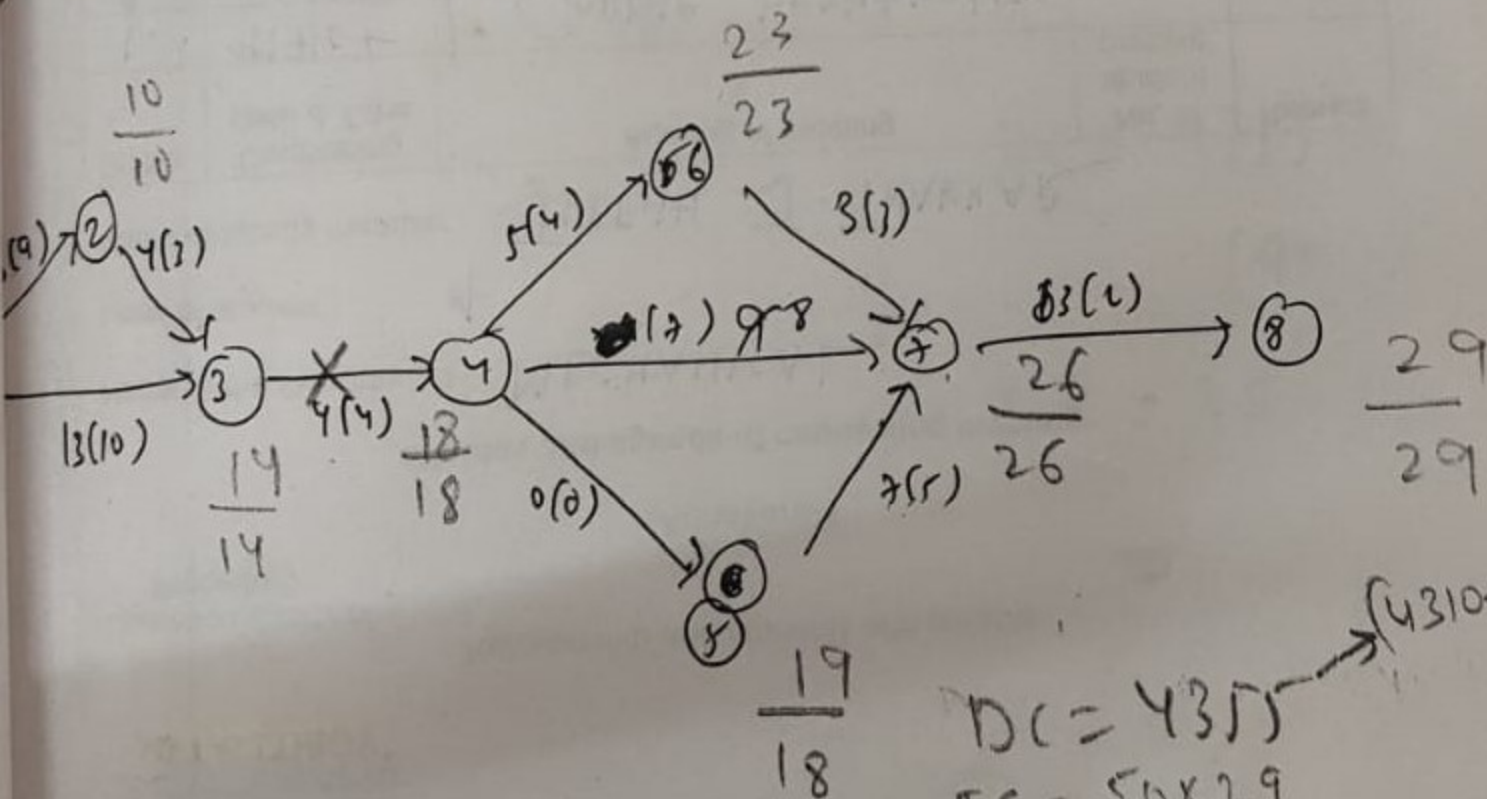


$$DC = 4310$$

1-2-3-4-7-8

$$4265 + (1 \times 45) + (50 \times 30) = 5810 //$$

Cram 4-7 by 1 week



$$DC = 4315$$

$$IC = 50 \times 29$$

1-2-3-4-7-8

1-2-3-4-7-8

5805/-

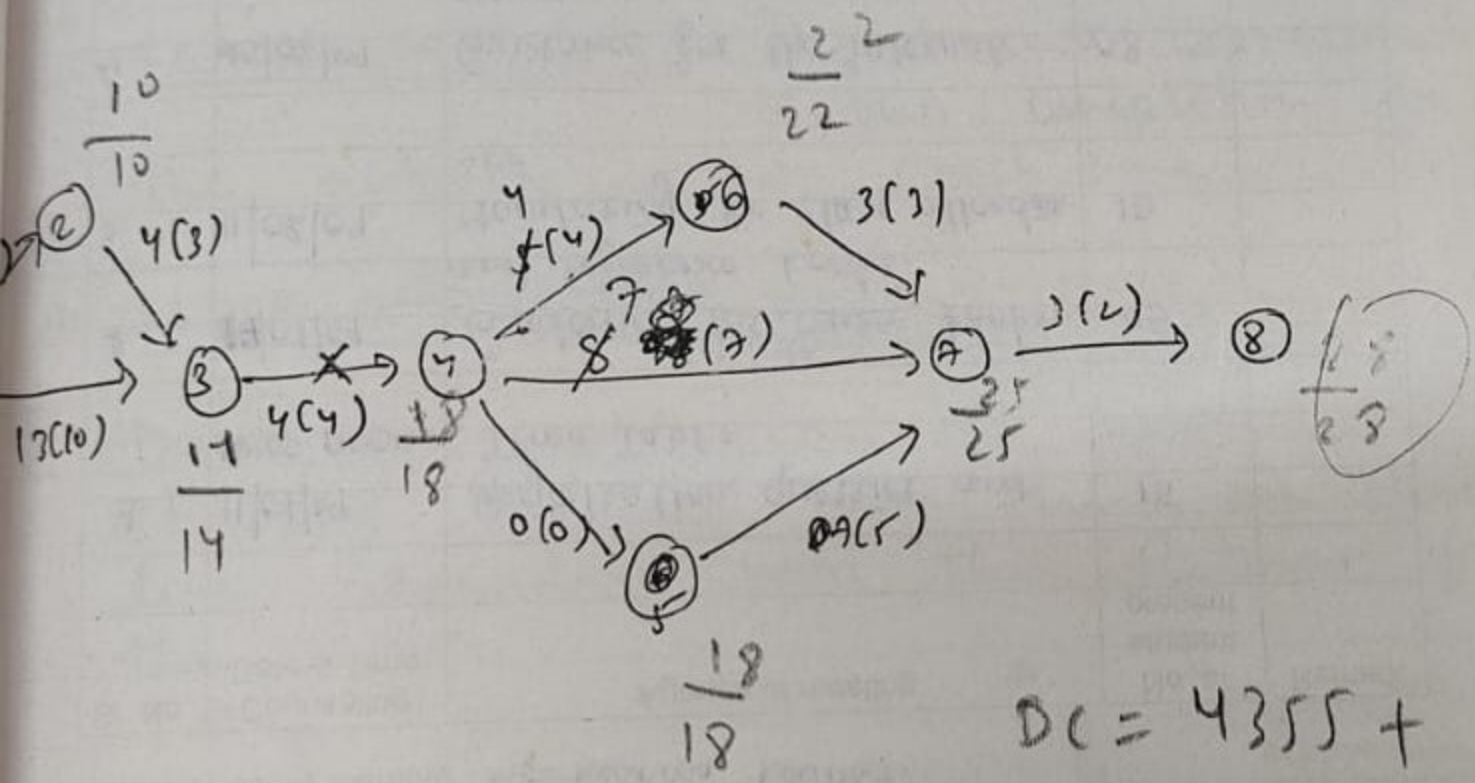
(4)

(4)

phases - 1

1	4-6, 4-7	50 + 45 = 95
2	6-7, 4-7	80 + 45 = 125

earn 4-6 by 1 day
 4-7 by 1 day



$$DC = 4355 + (95) = 4450$$

$$TC = 28 \times 50$$

$$TC = 5850$$

Ans → Iteration - (3)

$$TC = 5805 \text{ (29 days).}$$