ESE GATE PSUs

State Engg. Exams

MADE EASY Workbook 2025

Detailed Explanations of Try Yourself *Questions*

Civil Engineering

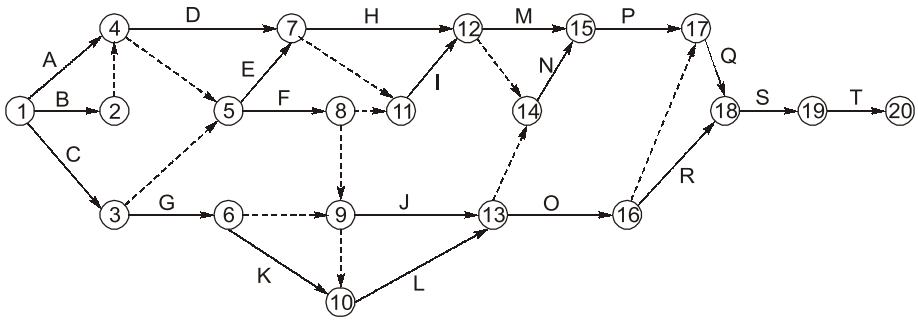
Construction Practice, Planning & Management

MADE EASY PUBLICATIONS

1 Basics of Project Management & Network Analysis

Detailed Explanation of Try Yourself Questions

T1 : Solution

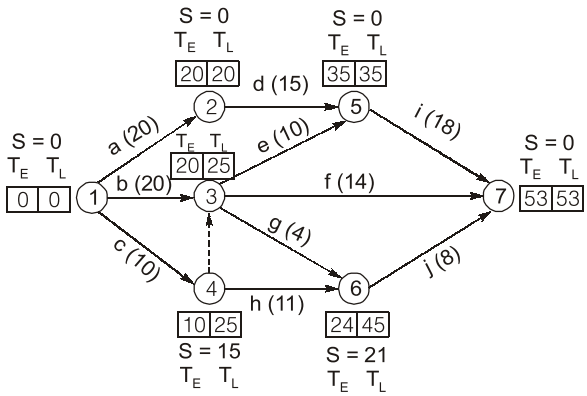


2 PERT Analysis

Detailed Explanation of Try Yourself Questions

T1 : Solution

Activity	t_0	t_m	t_p	t_e	Variance (σ^2)	σ
a	10	22	22	20	4	2
b	20	20	20	20	0	0
c	4	10	16	10	4	2
d	2	14	32	15	25	5
e	8	8	20	10	4	2
f	8	14	20	14	4	2
g	4	4	4	4	0	0
h	2	12	16	11	5.4	2.32
i	6	16	38	18	28.4	5.33
j	2	8	14	8	4	2



Critical path is 1-2-5-7 and schedule completion time of project = 53 days

Standard deviation, $\sigma = \sqrt{\sigma_a^2 + \sigma_d^2 + \sigma_i^2} = \sqrt{4 + 25 + 28.4} = 7.576$

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

For 95% probability $z = 1.5 + \dfrac{2.0 - 1.5}{97.92 - 93.92}(95 - 93.92) = 1.635$

$\therefore \quad 1.635 = \dfrac{T_s - 53}{7.576} \Rightarrow T_s = 65.38 \approx 66$ days

$\therefore$ Time for 95% probability completion is 66 days.

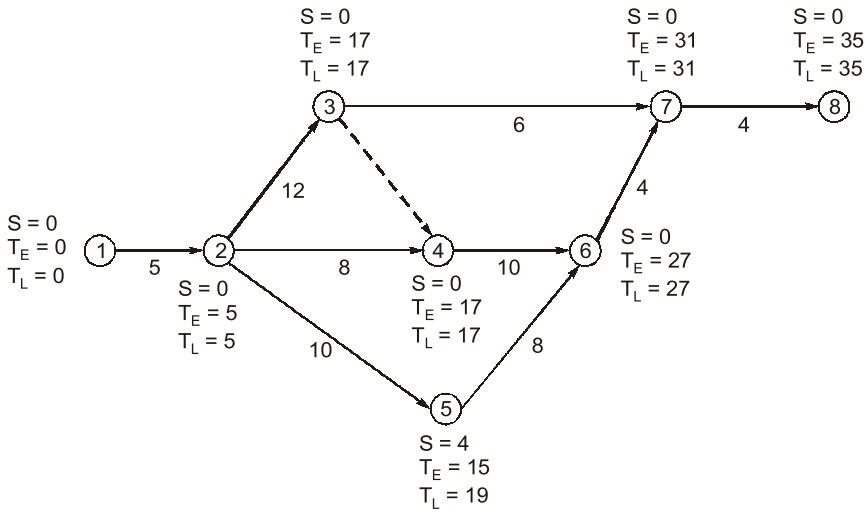
T2 : Solution

Calculation of expected time and standard deviation is done in table below:

Where, $t_e = \dfrac{t_0 + 4t_m + t_p}{6}$, $\sigma = \dfrac{t_p - t_0}{6}$

Activity	t_0	t_m	t_p	t_e	σ
1 - 2	2	5	8	5	1
2 - 3	8	11	20	12	2
2 - 4	4	7	16	8	2
2 - 5	4	9	20	10	2.67
3 - 4	0	0	0	0	0
3 - 7	3	5	13	6	1.67
4 - 6	7	10	13	10	1
5 - 6	3	7	17	8	2.33
6 - 7	2	3	10	4	1.33
7 - 8	2	4	6	4	0.67

Calculation of T_E, T_L and slack has been done in network diagram below:



$$\sigma = \sqrt{1^2 + 2^2 + 0^2 + 1^2 + 1.33^2 + 0.67^2} = 2.867$$

$$Z = \frac{T_S - T_E}{\sigma}$$

For 95% probability,

$$Z = 1.6 + \frac{0.1}{95.54 - 94.52} \times 0.48 = 1.647$$

$$1.647 = \frac{T_S - 35}{\sigma}$$

$$T_S = 1.647 \times 2.567 + 35 = 39.72$$

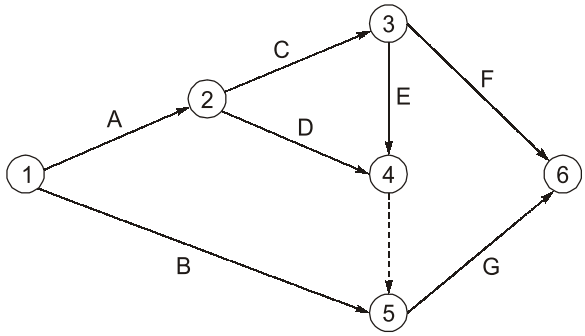
3 CPM Analysis

Detailed Explanation of Try Yourself Questions

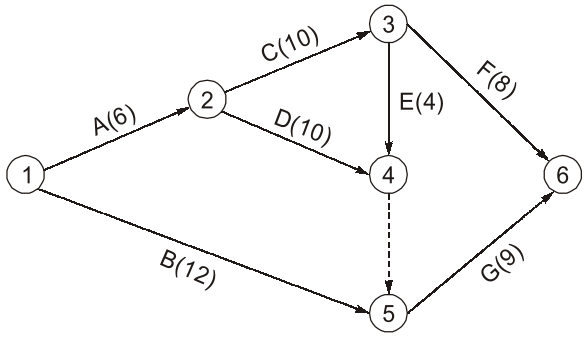
T1 : Solution

Activity	A	*B*	*C*	*D*	*E*	*F*	Dummy	*G*
Depends upon	–	–	*A*	*A*	*C*	*C*	*D*, *E*	*B*, Dummy
Duration, days	6	12	10	10	4	8	–	9

(i) Network diagram

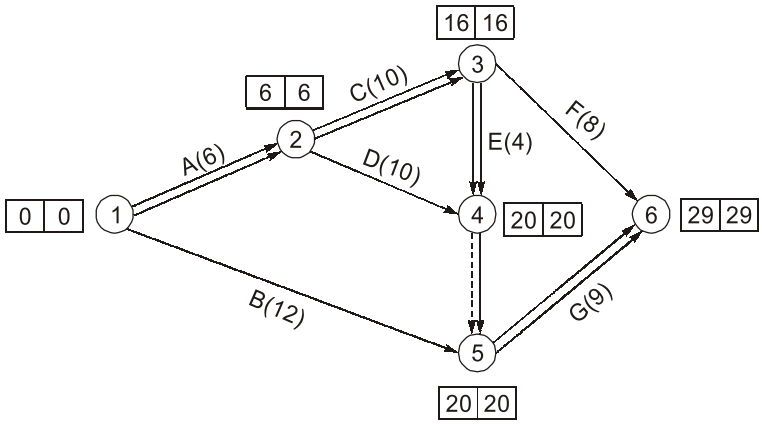


(ii) Project duration

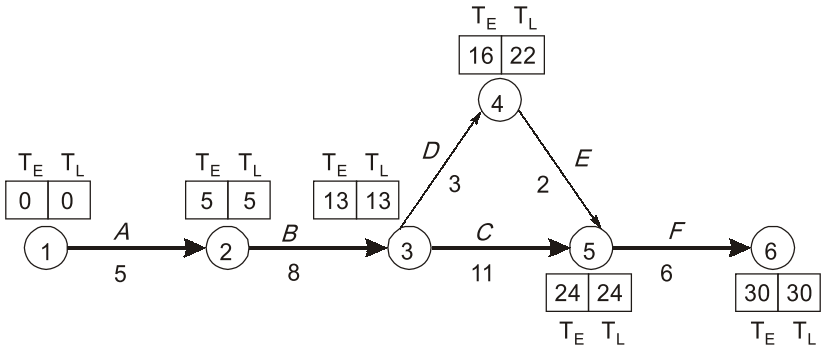


Calculation of critical path:

(1)-(2)-(3)-(6) ≡ 6 + 10 + 8 = 24 days
(1)-(2)-(3)-(4)-(5)-(6) ≡ 6 + 10 + 4 + 9 = 29 days
(1)-(2)-(4)-(5)-(6) ≡ 6 + 10 + 9 = 25 days
(1)-(5)-(6) ≡ 12 + 9 = 21 days
Critical path ≡ (1)-(2)-(3)-(4)-(5)-(6)
Project duration = 29 days



T2 : Solution



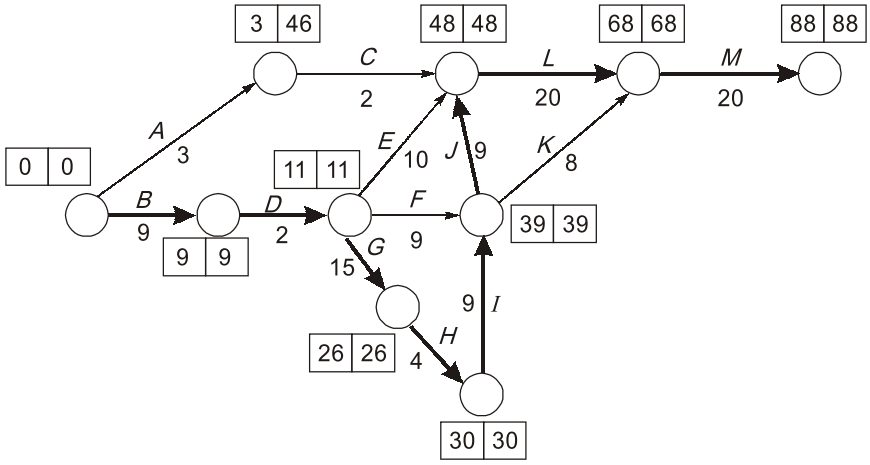
The critical path is 1 – 2 – 3 – 5 – 6
Project duration : 30 days

EST = T_E^i
EFT = EST + t^{ij}
LST = LFT – t^{ij}
LFT = T_L^i

Incorporating above formulas, all the activity times of the given network are shown in table below:

Activity	Tail event		Head event		Duration	EST	EFT	LST	LFT
	T_E^i	T_L^i	T_E^j	T_L^j	t_L^{ij}				
1 – 2	0	0	5	5	5	0	5	0	5
2 – 3	5	5	13	13	8	5	13	5	13
3 – 4	13	13	16	22	3	13	16	19	22
3 – 5	13	13	24	24	11	13	24	13	24
4 – 5	16	22	24	24	2	16	18	22	24
5 – 6	24	24	30	30	6	24	30	24	30

T3 : Solution



Project duration : 88 days

Activity times are

$$\text{EST} = T_E^i$$

$$\text{EFT} = \text{EST} + t^{ij}$$

$$\text{LST} = \text{LFT} - t^{ij}$$

$$\text{LFT} = T_L^j$$

$$\text{Total float, } F_T = T_L^j - T_E^i - t^{ij} = LFT - EFT$$

$$\text{Free float, } F_F = F_T - S_i = F_T - \left(T_L^j - T_E^i\right)$$

$$\text{Independent float, } F_I = T_E^j - T_L^i - t^{ij} = F_F - S_i$$

$$= F_F - \left(T_L^i - T_E^i\right)$$

Incorporating the above formula, the elements of table given below are calculated:

Activity	Tail event		Head event		Duration	Activity times				F_T	F_F	F_I
	T_E^i	T_L^i	T_E^j	T_L^j	t^{ij}	EST	EFT	LST	LFT			
A	0	0	3	46	3	0	3	43	46	43	0	0
B	0	0	9	9	9	0	9	0	9	0	0	0
C	3	46	48	48	2	3	5	46	48	43	43	0
D	9	9	11	11	2	9	11	9	11	0	0	0
E	11	11	48	48	10	11	21	38	48	27	27	27
F	11	11	39	39	9	11	20	30	39	19	19	19
G	11	11	26	26	15	11	26	21	26	0	0	0
H	26	26	30	30	4	26	30	26	30	0	0	0
I	30	30	39	39	9	30	39	30	39	0	0	0
J	39	39	48	48	9	39	48	39	48	0	0	0
K	39	39	68	68	8	39	47	60	68	21	21	21
L	48	48	68	68	20	48	68	48	68	0	0	0
M	68	68	88	88	20	68	88	68	88	0	0	0

Critical path of the network is B – D – G – H – I – J – L – M

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4 CPM Cost Model Analysis

Detailed Explanation of Try Yourself Questions

T1 : Solution

Total direct cost (normal) of the project = 250 + 350 + 300 + 700 = ₹ 1600

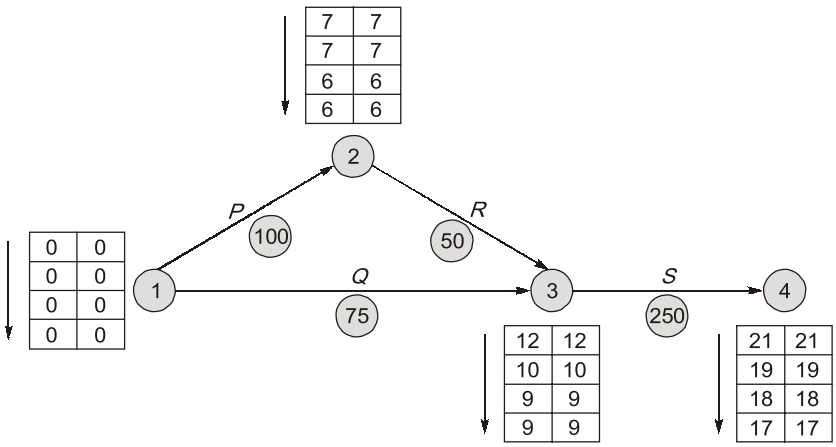
$$\text{Cost slope of } P = \frac{350-250}{7-6} = ₹100/\text{ day}$$

$$\text{Cost slope of } Q = \frac{500-350}{10-8} = ₹75/\text{ day}$$

$$\text{Cost slope of } R = \frac{400-300}{5-3} = ₹50/\text{ day}$$

$$\text{Cost slope of } S = \frac{950-700}{9-8} = ₹250/\text{ day}$$

Normal duration, crash duration and cost slope of each activity is indicated on the arrow diagram as shown below.



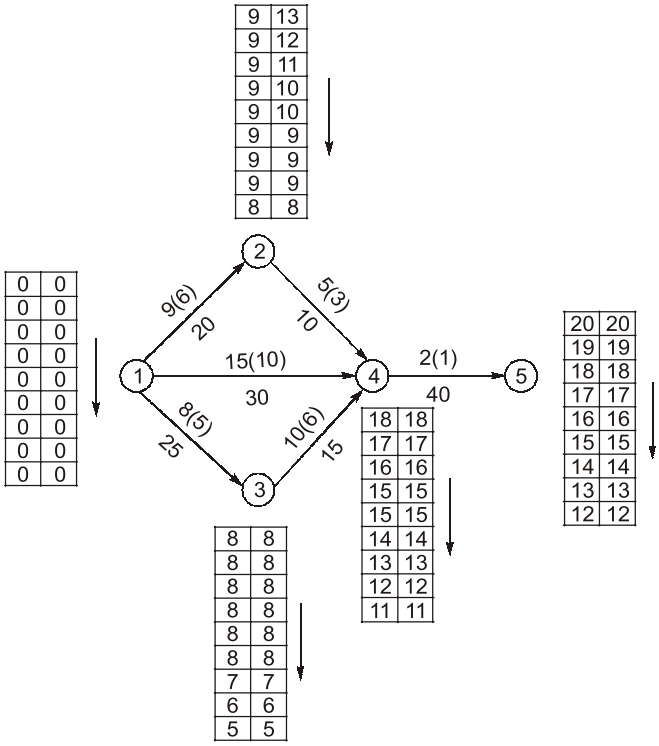
S.No	Description	Duration (Days)	Indirect Cost (₹)	Direct Cost (₹)	Total Project Cost (₹)	Remarks
1	All Normal	21	3990	1600	5590	Normal duration
2	Crashing R by 2 days	19	3610	1700	5310	
3	Crashing P and Q each by 1 day simultaneously	18	3420	1875	5295	Optimum duration
4	Crashing S by 1 day	17	3230	2125	5355	Minimum duration

Optimum duration of the project=18 days

Minimum (all crash) duration of the project = 17 days

T2 : Solution

The mathematical modelling of CPM network is shown in the figure below:



Sl. No.	Description	Project duration (days)	Indirect cost (₹)	Direct cost due to crashing (₹)	Total cost (₹)	Remarks
1.	All normal	20	1200	—	1200	Normal Length
2.	Crashing (3-4) by 1 day	19	1140	15	1155	
3.	Crashing (3-4) by 1 day	18	1080	30	1110	
4.	Crashing (3-4) by 1 day	17	1020	45	1065	
5.	Crashing (4-5) by 1 day	16	960	85	1045	
6.	Crashing (3-4) and (1-4) by 1 day	15	900	130	1030	Optimum Length
7.	Crashing (1-3) (2-4) and (1-4) each by 1 day	14	840	195	1035	
8.	Crashing (1-3) (2-4) and (1-4) each by 1 day	13	780	260	1040	
9.	Crashing (1-3) (1-2) and (1-4) each by 1 day	12	720	335	1055	Minimum Length

No further crashing since one of parallel critical paths is saturated.

Normal project length = 20 days

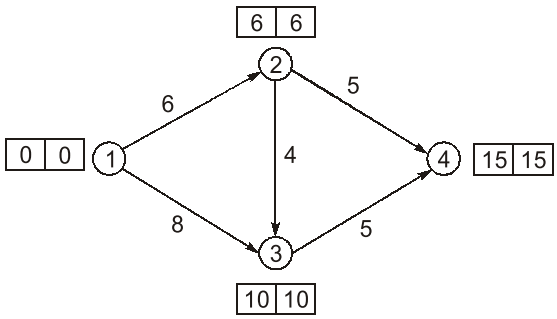
Optimum project length = 15 days

Minimum project length = 12 days.

Seven days scheduling (each by one day) is from s.no. 2 to 8 in the table.

T3 : Solution

Network diagram corresponding to the given data:

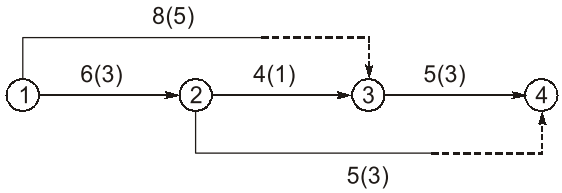


So critical path is 1-2-3-5

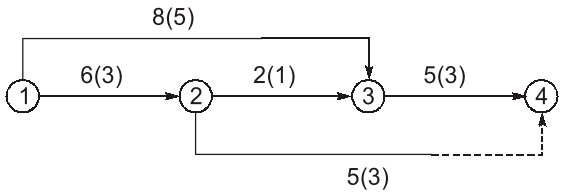
Now, cost slopes for the various activities can be found out as,

Activity	Cost slope = $\left(\frac{c_c - c_n}{t_n - t_c}\right)$
1–2	2500
1–3	1500
2–3	1000
2–4	3500
3–4	3000

Cost of project = DC + IC
DC = Rs. 30,000
IC = 15 × 3000 = Rs. 45000
TC = Rs. 75000



1st stage: Crashing (2)-(3) by 2 weeks.

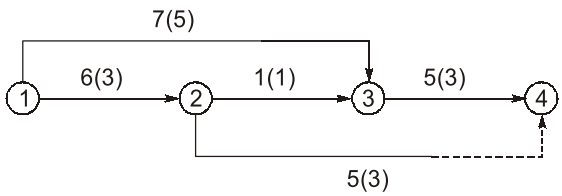


Duration of project = 13 weeks

Cost of project:

DC = 30000 + 2 × 1000 = Rs. 32000
IC = 13 × 3000 = Rs. 39000
TC = Rs. 71000

2nd stage: Crashing (1)-(3) and (2)-(3) simultaneously by 1 week

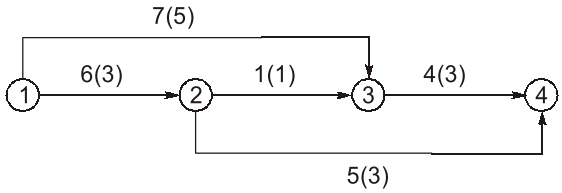


Duration of project = 12 weeks

Cost of project:

DC = 32000 + 1000 + 1500 = Rs. 34500
IC = 12 × 3000 = Rs. 36000
TC = Rs. 70500

3rd stage: Crashing (3)-(4) by 1 week

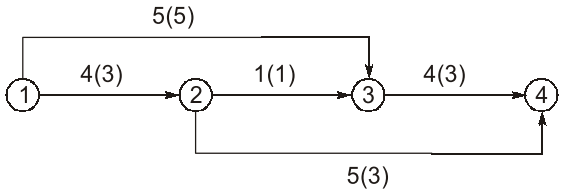


Duration of project = 11 weeks

Cost of project:

DC = 34500 + 3000 = Rs. 37500
IC = 11 × 3000 = Rs. 33000
TC = Rs. 70500

4th stage: Crashing (1)-(2) and (1)-(3)



Duration of project = 9 weeks

Cost of project:

DC = 37500 + (2500 + 1500) × 2 = Rs. 45500
IC = 9 × 3000 = 27000
TC = 72500

Since cost will increasing for further stage of crushing.

∴ Optimum time = 11 weeks
Minimum cost = Rs. 70500

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