SECTION-A

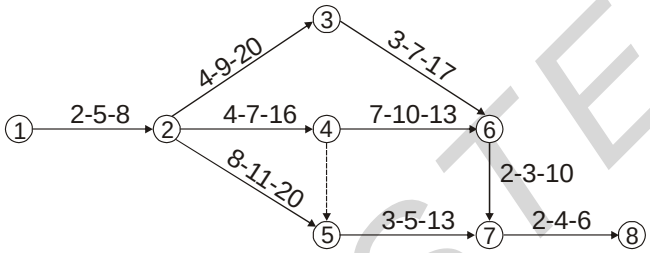
1. (a) For the given PERT network, determine

(i) Expected time, Standard deviation and variance of the PROJECT and show the critical path also.

(ii) Probability of completion of project in 34 days.

(iii) Time duration that will provide 90% probability of its completion in time.

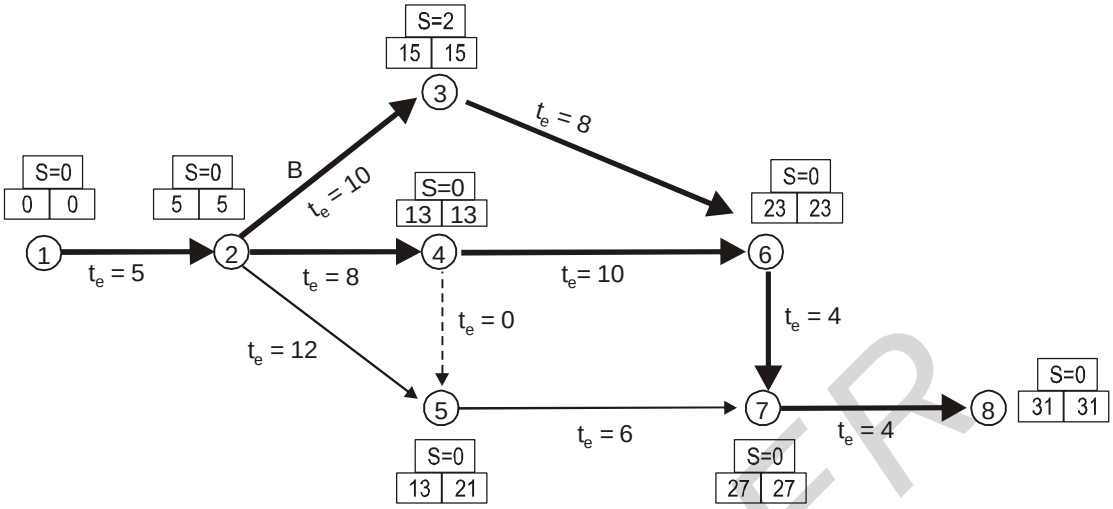
The three time estimates of each activity are mentioned on the network. **[10 Marks]**



Z	–0.7	–0.8	–0.5	–0.9	–1.28
P	24.20	21.19	30.85	18.41	10.00

Sol. 1(a)

Act	t_0	t_m	t_p	t_e	σ	σ^2
1–2	2	5	8	5	1	1
2–3	4	9	20	10	2.67	7.13
2–4	4	7	16	8	2	4
2–5	8	11	20	12	2	4
4–5	0	0	0	0	0	0
3–6	3	7	17	8	2.33	5.43
4–6	7	10	13	10	1	1
5–7	3	5	13	6	1.67	2.78
6–7	2	3	10	4	1.33	1.77
7–8	2	4	6	4	0.67	0.45



Project completion time = 31 days.

Critical paths are

(a) 1–2–3–6–7–8

(b) 1–2–4–6–7–8

As there are two critical paths, hence to determine most critical path we have to find out variance.

For path (a) $\sigma = \sqrt{1+7.13+5.43+1.77+0.45} = 3.97$

For path (b) $\sigma = \sqrt{1+4+1+1.77+0.45} = 2.87$

Hence most critical path is (a) i.e. 1–2–3–6–7–8

Probability corresponding 34 days

$$Z = \frac{T_S - T_E}{\sigma} = \frac{34-31}{3.97} = +0.756$$

$$p = 75.80 + \frac{78.81-75.80}{0.1} \times 0.056 = 77.486\%$$

T_s for p = 90%

$\because$ Z = 1.28 for p = 90%

$$1.28 = \frac{T_S - 31}{3.97}$$

$$T_S = 36.082 \text{ days}$$

1 (b) The delivery price of an equipment is Rs. 1.10 lakh and its installation charge is Rs. 10000, Life of the equipment is 6 years, the rate of interest (i) for sinking fund is 8%. Calculate the depreciation for the 4th year and book value at the end of 4th year by the following methods.

(a) Sink fund method

(b) Sum of digits of years method **[10 Marks]**

Sol. 1. (b) $C_i = 1,10,000$, $C_s = 10,000$ n = 6 yr, i = 8%

Sinking fund method.

$$D = \left(\frac{C_i - C_s}{n}\right) \times \frac{i}{(1+i)^n - 1}$$

$$D = \left(\frac{110000 - 10000}{6}\right) \times \frac{0.08}{(1.08)^6 - 1}$$

$$D = 2271.92$$

Depreciation at the 4th year.

$$D_4 = 2271.92(1.08)^{4-1} = 2861.96 \cong 2862$$

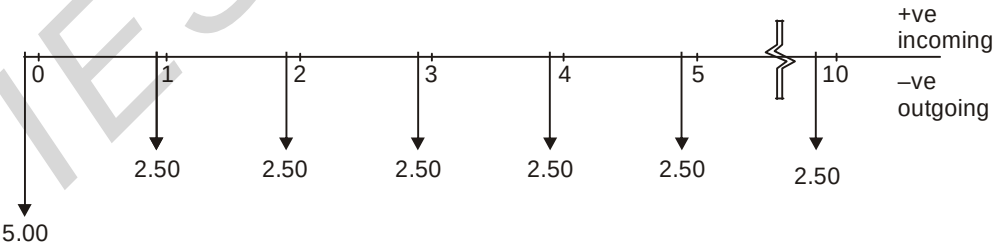
Sum of digits of year method

$$D_m = \left(\frac{n - m + 1}{\frac{n(n+1)}{2}}\right)(C_i - C_s)$$

$$D_4 = 1,00,000 \times \left(\frac{6 - 4 + 1}{6 \times \frac{7}{2}}\right) = 14285.71 \cong 14286$$

2. (a) An alternative, A requires an initial investment of Rs. 500,000 and an annual expense of Rs. 250,000 for the next 10 years. Alternative B, on the other hand, requires an initial investment of Rs. 750,000 and an annual expense of Rs. 200,000 for the next 10 years. Which alternative would you prefer if interest rate were 10 per cent? **[10 Marks]**

Sol. 2. (a) The cash-flow diagram corresponding to alternative A is given below

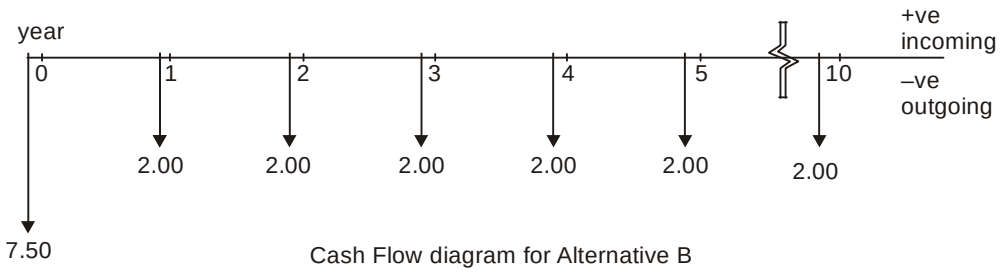


Present cost of alternative A = 500000 + 250000 (P/A, 10%, 10)

= 500000 + 250000 (6.1446)

= Rs. 2036150.00

The cash-flow diagram corresponding to alternative B is given below



Cash Flow diagram for Alternative B

Present cost of alternative B = 750000 + 200000 (P/A, 10%, 10)

= 750000 + 200000(6.1446)

= Rs. 1978920.00

It can be noticed from the two cash-flow diagrams that the cost data alone are provided. Thus, alternative with the lowest cost at present time would be the most preferable. In this case, since the present cost for alternative B is less than that of alternative A, it is preferable to choose alternative B.

2. (b) The two machines A and B have the following costs with the money worth as 8% per year;

	A	**B**
First cost	Rs 10,000	Rs 25,000
Salvage value	Rs 1,100	Rs 1,500
Uniform expenditure at end of year	Rs 3,000	Rs 2,000
Irregular expenses at end of 1st year	Rs 1,000	–
Irregular expenses at end of 3rd year	–	Rs 2,500
Benefit from quality control (at end of year)	–	Rs 600
Life	2 years	5 years

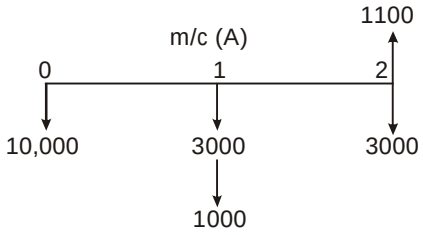
Compare the machines for suitablity of selection on the following bases;

(i) Present worth

(ii) Equivalent Annual cost worth

(iii) Capitalized cost worth **[10 Marks]**

Sol. 2.(b) The fig shows the cash flow diagram for life of 2 years.

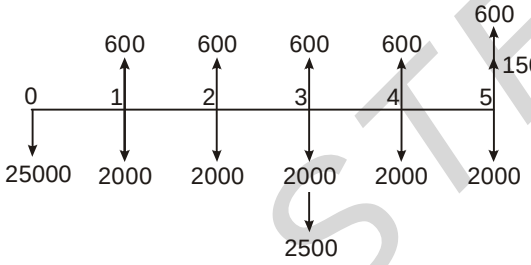


$P_A(2)$ = Present worth of m/c (A) at 0 time of its life period (2 years)

$$= 10000 + 3000\left(\frac{P}{A},8\%,2\right) - 1100\left(\frac{P}{F},8\%,2\right) + 1{,}000\left(\frac{P}{F},8\%,1\right)$$

$$= 10000 + 3000\left[\frac{(1.08)^2 - 1}{(0.08)(1.08)^2}\right] - 1100\left[\frac{1}{(1.08)^2}\right] + 1000\left[\frac{1}{1.08}\right] = \text{Rs } 15{,}333$$

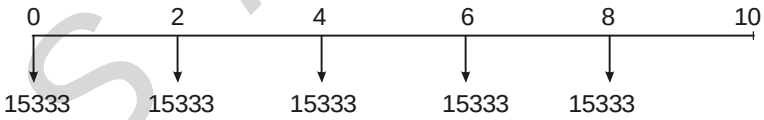
$P_B(5)$ = Present worth of m/c (B) at 0 time of its own life period (5 years)



$$= 25000 + (2000 - 600)\left[\frac{P}{A},8\%,5\right] + 2500\left[\frac{P}{F},8\%,3\right] - 1500\left[\frac{P}{F},8\%,5\right]$$

$$= 25000 + 1400\left[\frac{(1+0.08)^5 - 1}{(0.08)(1+0.08)^5}\right] + 2500\left[\frac{1}{(1+0.08)^3}\right] - 1500\left[\frac{1}{(1.08)^5}\right] = \text{Rs } 31{,}553$$

Since the lives of machines are different. The common life period will be L.C.M. of their lives i.e. L.C.M. of 2 and 5 i.e. 10 years.

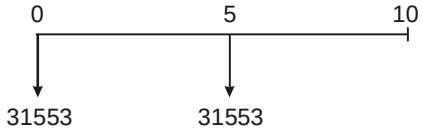


$\therefore$ $P_A(10)$ = overall present worth of machine A on the basis of 10 yrs period

$$= 15333 + 15333\left(\frac{P}{F},8\%,2\right) + 15333\left(\frac{P}{F},8\%,4\right) + 15333\left(\frac{P}{F},8\%,6\right) + 15333\left(\frac{P}{F},8\%,8\right)$$

$$= 15333 + 15333\left[\frac{1}{(1.08)^2} + \frac{1}{(1.08)^4} + \frac{1}{(1.08)^6} + \frac{1}{(1.08)^8}\right] = \text{Rs } 57{,}695$$

$P_B(10)$ = Overall present worth of machine is for common life period of 10 yrs.



$$= 31553 + 31553\left[\frac{P}{F},8\%,5\right]$$

$$= 31553 + 31553\left[\frac{1}{(1.08)^5}\right] = 53,027$$

Since $P_B(10) < P_A(10)$

$\therefore$ Machine B is selected

(ii) Equivalent Annual worth method

$A_{(A)}$ = Equivalent Annual worth of machine A

$$= P_A(2)\left[\frac{A}{P}, i, n\right] = 15333\left[\frac{0.08(1+0.08)^2}{(1+0.08)^2 - 1}\right] = \text{Rs } 8598$$

Similarly,

$A_{(B)}$ = Equivalent annual worth of machine (B)

$$= P_B(5)\left[\frac{A}{P}, 8\%, 5\right] = 31553\left[\frac{(0.08)(1+0.08)^5}{(1+0.08)^5 - 1}\right] = \text{Rs } 7903$$

Since $A_{(B)} < A_{(A)}$

$\therefore$ Machine B is selected

(iii) Capitalized Cost Method

$C_{(A)}$ = Capitalized worth of machine A

$$= \frac{\text{Equivalent annual worth of machine A}}{i} = \frac{8598}{0.08} = 107,475$$

$$C_B = \frac{7903}{0.08} = 98787$$

Since $C_B < C_A$

$\therefore$ Machine B is selected.

3. (a) What is the present equivalent value of Rs. 50000, five years from now at 14% per annum compounded semi-annually? **[10 Marks]**

Sol. 3 (a)

$\because$ Nominal intrest rat is 14% per annum

$\therefore$ If compunded half yearly nominal intrest rate is 7%

$$\frac{P}{F} = \frac{1}{(1+i)^n}$$

$$P = \frac{50000}{(1+0.07)^{10}}$$

$$P = \text{Rs. } 25417$$

3. (b) Determine the gradability of a crawler tractor pulling a high pressure rubber tyred self loading scraper and its load. The following information is available:

Tractor HP = 200

Weight of tractor = 18.5 t

Weight of loaded scraper = 31.5 t

Rated drawbar pull of tractor = 14.8 t

Rolling resistance for the tractor = 90 kg/t

Rolling resistance for the scraper = 105 kg/t

Take pull required per tonne for the unit per 1% slope = 10 kg

Assume available drawbar pull as 0.85 times the rated drawbar pull of tractor.

[10 Marks]

Sol. 3 (b) Applying suitable factor of safety on rated drawbar pull.

Available drawbar pull = 0.85 × 14.8 × 1000 = 12580 kg

Since the design of crawler tractor as per manufacturer's specifications is based on the rolling resistance of 55 kg/t,

$\therefore$ Rolling Resistance to be overcome by the tractor = 18.5 × (90 – 55) = 647.5 kg

Rolling Resistance to be overcome by the scraper = 31.5 × 105 = 3307.5 kg

$\therefore$ Combined Rolling Resistance to be overcome by the unit

= 647.5 + 3307.5 = 3955 kg

$\therefore$ Net pull available to negotiate the grade = (12,580 – 3955) kg = 8625 kg

Combined weight of the unit = 18.5 + 31.5 = 50.0 t

The pull required per tonne for the unit per 1% slope = 10 kg

$\therefore$ The pull required for 50 tonne of the unit per 1% slope = 10 × 50 = 500 kg

500 kg pull is required for 1% slope

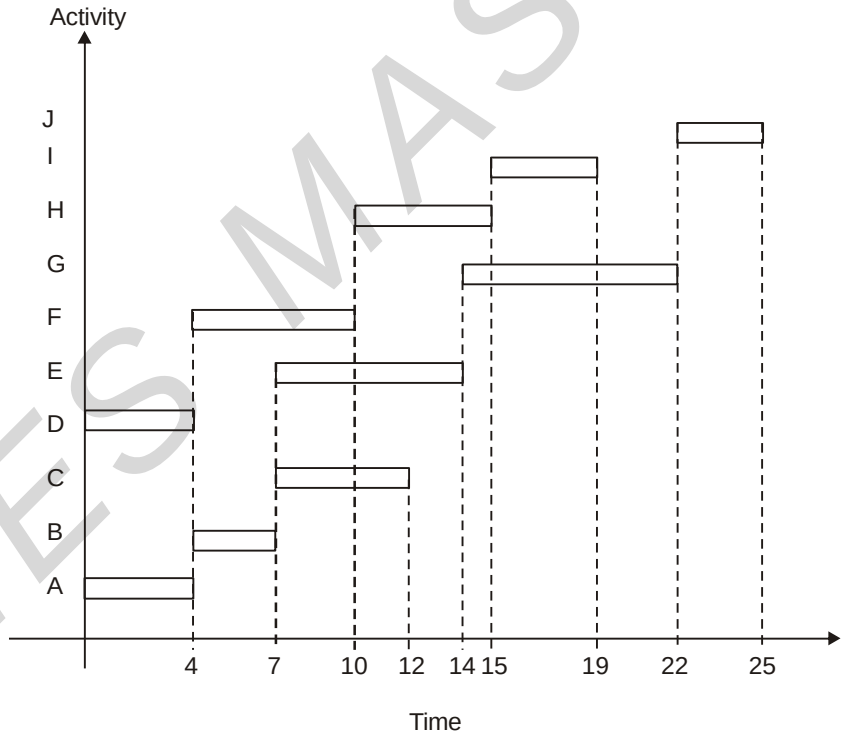
$\therefore$ 8625 kg pull is required for $\frac{8625}{500}$ = **17.25%** Ans.

4. (a) Construct a bar chart for a project with the activity data as noted below. Also compute the total duration of the project.

Activities	Duration (days)	Preceded by
A	4	None
B	3	A
C	5	B
D	4	None
E	7	B, D
F	6	D
G	8	E
H	5	F
I	4	H
J	3	G, I

[10 Marks]

Sol. 4(a)



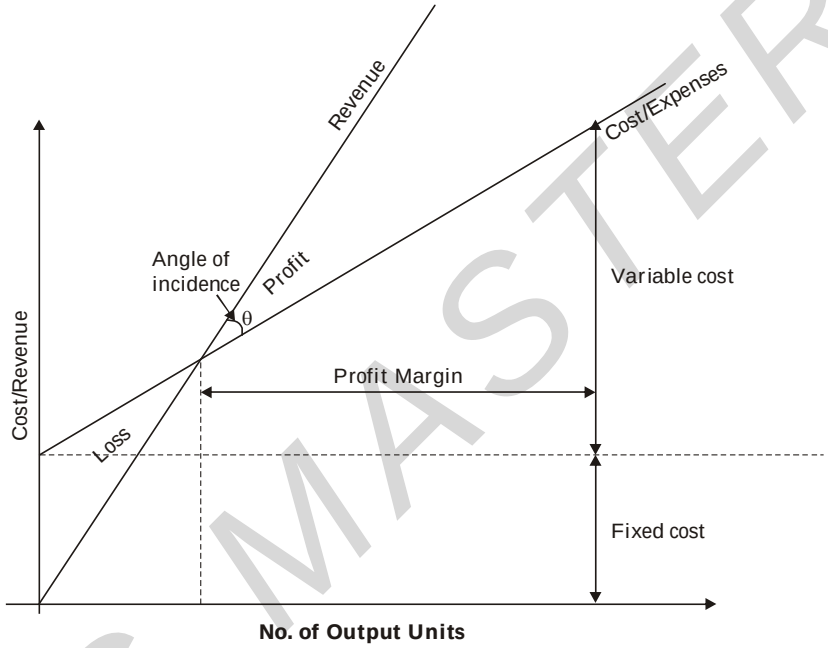
Total duration project is 25 days

4. (b) What is Break even Analysis? Write functions and limitations of break even analysis

[10 Marks]

Sol. 4.(b) Break even Analysis

- Break even Analysis is a graphical representation of the relationship between cost and revenue for all possible volume of output.
- Break even analysis is basically done to find out the point at which total revenue equals total cost & profit potential under varying conditions of out put and cost.
- Break Even point is therefore at which neither a profit nor a loss is incurred.
- Sometimes it is also called as Cost–Volume–profit studies.



Functions

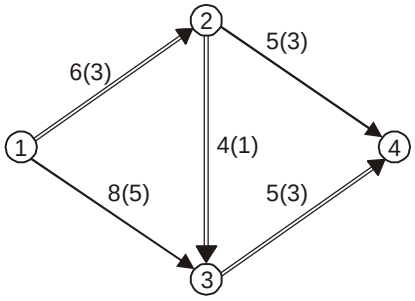
1. Suitable for business firm to study cost revenue relationship.
2. Useful in making engineering decisions.
3. Useful in selection of favourable option of business.
4. Possibility of profit is determined for any rate of production.
5. It shows weather business is good or bad by angle of incidence. Greater the angle of incidence means more profit margin and, we know that profit margin should be more for good business.

Limitations

1. Break even analysis is a nice tool for small business.
2. It provides a static picture where as business processes are dynamic in nature because the market conditions do not remains constant.
3. Revenue line may not be always a straight line.
4. Analysis of break even becomes difficult when company produces different/variety of products.
5. Cost and revenue are related only with number of units produced. They have no relation with the time.

SECTION-B

5. (a) The following table gives the data for the duration and costs of each activity of a project network shown in figure. The indirect cost of the project is Rs. 3000/week. Determine the optimum duration of project and the corresponding minimum cost. Draw the time scaled version of the network.

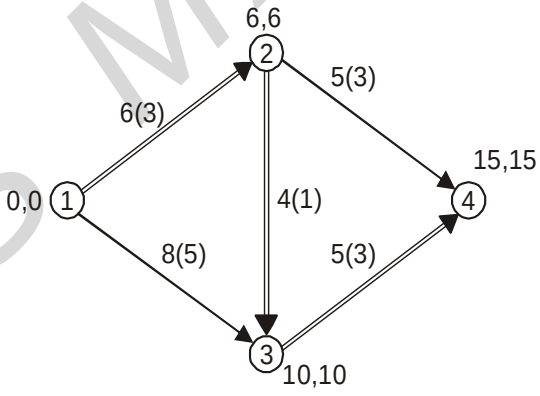


Activity	Normal Duration (week)	Normal Cost Rs.	Crash Duration (week)	Crash Cost Rs.
1 – 2	6	7000	3	14,500
1 – 3	8	4000	5	8,500
2 – 3	4	6000	1	9,000
2 – 4	5	8000	3	15,000
3 – 4	5	5000	3	11,000

Fig. (a): Network

[10 Marks]

Sol. 5(a)



Critical path is 1 – 2 – 3 – 4

Project duration = 15 weeks

Total project cost = Direct cost + Indirect cost

Direct cost = 7000 + 4000 + 6000 + 8000 + 5000 = 30,000

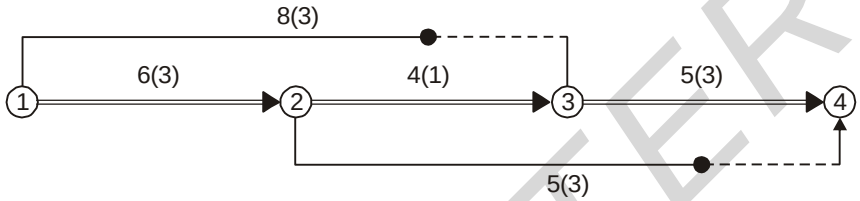
Indirect cost = 3000 × 15 = 45,000

T.P.C = 30,000 + 45,000 = 75,000

Calculation of cost slopes

Activity	ΔC (Rs.)	Δt [weeks]	Cost slope [Rs. / week]
1 – 2	14,500 – 7,000 = 7,500	6 – 3 = 3	2,500
1 – 3	8,500 – 4,000 = 4,500	8 – 5 = 3	1,500
2 – 3	9,000 – 6,000 = 3,000	4 – 1 = 3	1,000
2 – 4	15,000 – 8,000 = 7,000	5 – 3 = 2	3,500
3 – 4	11,000 – 5,000 = 6,000	5 – 3 = 2	3,000

Time Scaled version of network

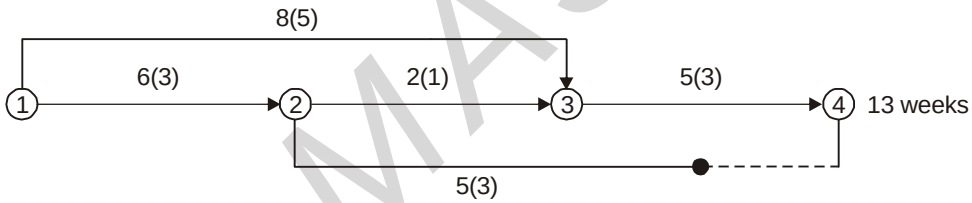


Ist Stage Crashing

Activity 2-63 has least cost slope among critical activites. Crash this activity by 2 weaks.

New project duration = 13 weeks.

T.P.C. 75,000 ~ 2 × 3000 + 2 × 10000 = 71,000



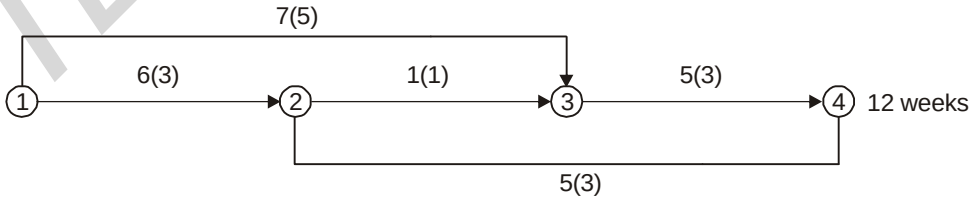
Stage-1: Duration 13 weeks

IInd Stage Crashing

Activity 2-3 and 1-3 has least combined cost slope i.e 2500. We will crash them simultaneously by 1 week.

New project duration = 12 weeks

T.P.C = 71000 + 1× 3000 + 1 × 2500 = 70500



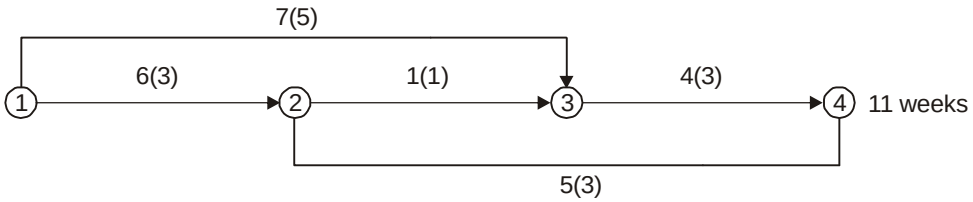
Stage-3: Duration 12 weeks

IIIrd Stage Crashing

Now activity 3-4 has least cost slope i.e. 3000, we will crash it by 1 week.

New project duration = 11 weeks.

T.P.C = 70500 – 1 × 3000 + 1 × 3000 = 70500



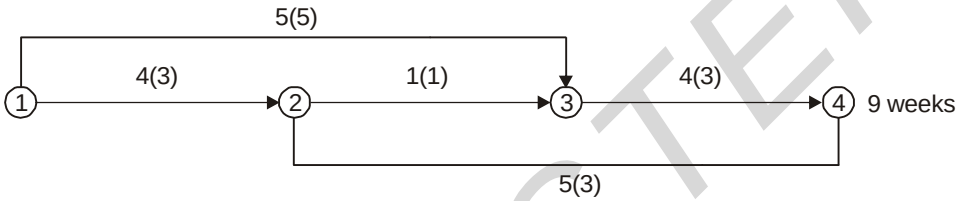
Stage-3: Duration 11 weeks

IVth Stage Crashing

Activity 1-3 and 1-2 have least combined cost slope i.e. 4000, we will crash it by 2 weeks.

New project duration = 9 weeks.

T.P.C. = 70500 – 2 ×.3000 + 2 × 4000 = 725000



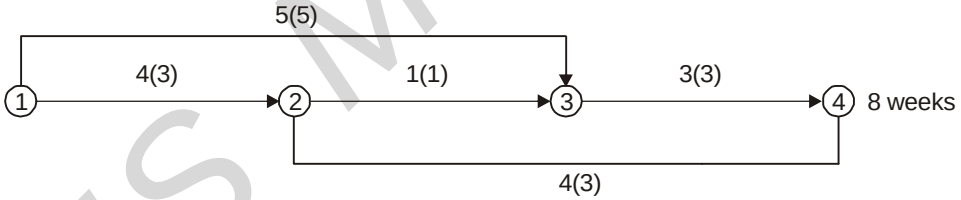
Stage-4: Duration 9 weeks

Vth Stage Crashing

Activity 3-4 and 2-4 can be crashed simultaneously by 1 weeks.

New project duration = 8 weeks.

T.P.C. = 72500 – 1 × 3000 + 1 × 6500 = 76000



Stage-5: Duration 8 weeks

Hence, the optimum project duration = 11 weeks.

The corresponding least cost = Rs. 70500.

5. (b) For the network shown in Fig. below assume that, after working 15 days on the project, the following conditions exist:

(a) Activities 1-2, 1-3 and 1-4 are complete as originally planned

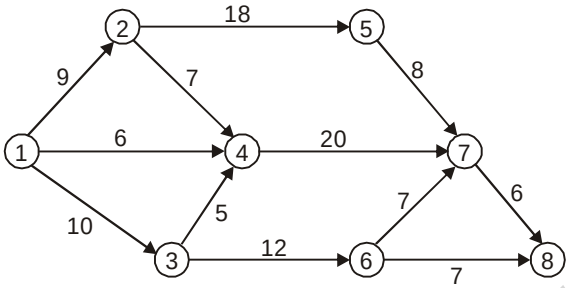
(b) Activity 2-4 is in process and will be completed in 3 more days

(c) Activity 3-6 is in process and will need 18 more days for completion

(d) Activity 6-7 appears to present some problem and its new estimated time of completion is 12 days.

(e) Activity 6-8 can be completed in 5 days instead of the originally planned 7 days.

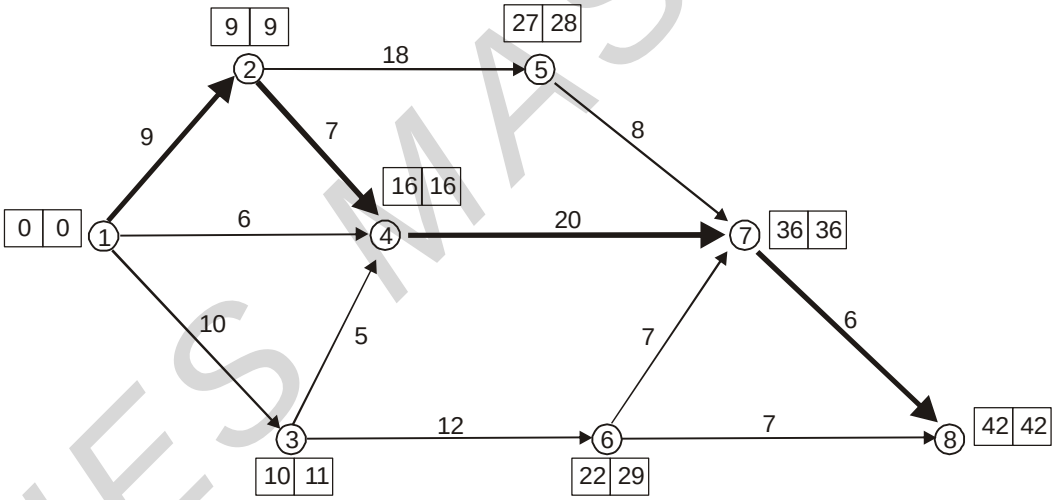
(f) No other activity have been started and the estimates of original time remains same.



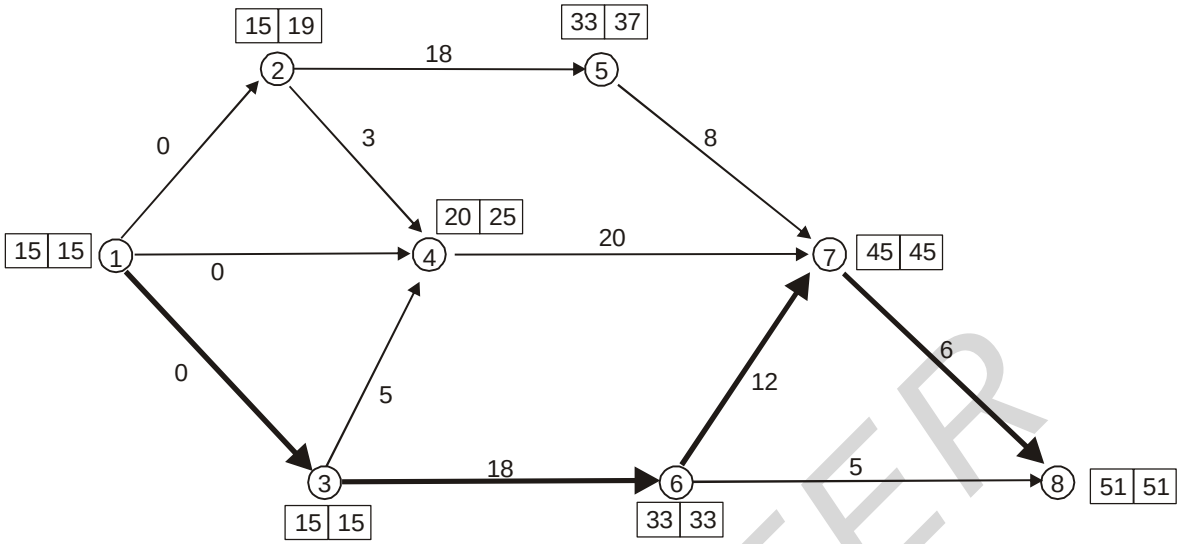
Update the network based on the assessment at the end of 15 days. Include all activities in the new project. **[10 Marks]**

Sol. 5(b)

Before Updating



Critical path is 1–2–4–7–8 after updating.

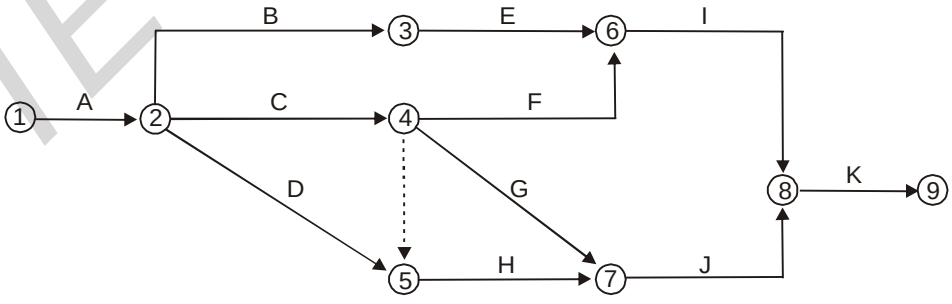


Now critical path will be 1–3–6–7–8.

6. (a) Draw the network for the the following project and number the events according to fulkerson's rule. **[10 Marks]**

Activity	Immediate Predecessor	Activity	Immediate Predecessor
A	–	G	C
B	A	H	C&D
C	A	I	E & F
D	A		
E	B	J	G & H
F	C	K	I & J

Sol. 6. (a)



6. (b) Discuss in brief types, basic parts and operations of power shovels.

[10 Marks]

Sol. 6. (b)

Power Shovels

- Basically a shovel is a tool for digging, lifting, and moving bulk materials, such as soil, coal, gravel, snow, sand, or ore.
- Shovels are extremely common tools that are used extensively in agriculture, construction, and gardening.
- When a shovel is mounted on a Power vehicle it is called as Power Shovel
- Power shovels are used mainly to excavate earth and load into trucks or tractor-drawn wagons.
- Power shovels can excavate all types of earth except solid rock without prior loosening.

Types of Power Shovels

1. Crawler mounted Shovels
2. Rubber Tyre mounted Shovels

Crawler mounted Shovels

- Crawler mounted Shovels are mounted on Crawler tracks.
- Crawler mounted Shovels have very low travel speed.
- Crawler mounted Shovels exert low pressure on the soil and hence suited for muddy and soft ground surface.

Rubber Tyre mounted Shovels

- Rubber Tyre mounted Shovels may be mounted on Rubber-tyres.
- Rubber-tyre-mounted shovels have higher travel speeds are useful for small jobs where considerable travelling is involved.
- Rubber-tyre-mounted shovels exert considerable pressure on the soil surface hence suited where the road and the firm ground surfaces.

The basic parts of a power shovel include

- Mounting
- Cab
- Boom
- Dipper stick
- Dipper
- Other attachments to the shovel include hoe, dragline, clamshell and crane.

Operations of Shovels

- Positioning the shovel near the face of the earth to be excavated.
- The dipper is lowered to the floor of the pit, with the teeth pointing into the face.
- A penetration force is applied through the dipper shaft and at the same time tension is applied to the hoisting line to pull the dipper up the face of the pit.
- If the depth of the face (called the depth of cut) is just right, the dipper will be filled as it reaches the top of the face.

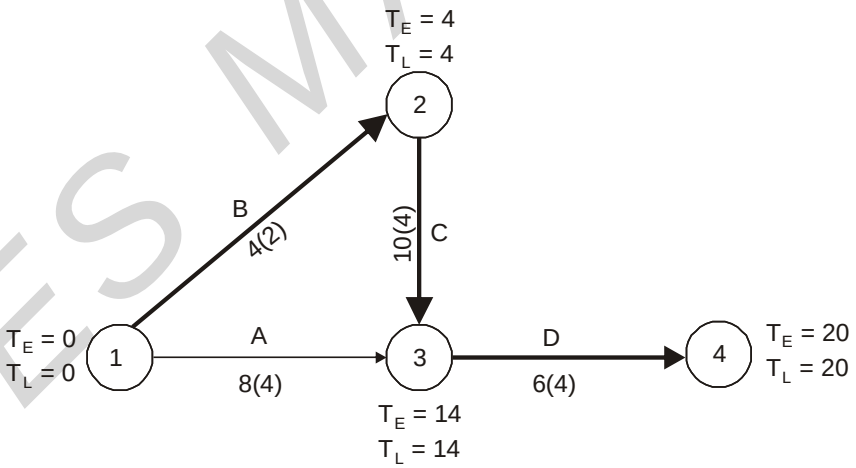
- If the depth is shallow it will not be possible to fill the dipper completely without excessive crowding and hoisting tension.
- If the depth of cut is more than is required to fill the dipper, the depth of penetration of the dipper into the face must be reduced if the full face is to be excavated or to start the excavation above the floor of the pit.

7.(a) A, B, C and D are the activities. Their normal and crash durations and associated costs are given in the table below:

Activity	Normal duration in days	Normal cost Rs.	Crash duration in days	Crash cost Rs.
A	8	6,000	4	12,000
B	4	2,000	2	14,000
C	10	4,000	4	8,000
D	6	4,000	4	8,000

For the entire project the indirect cost is Rs. 1000 per day. A and B are starting activities; C follows B; D follows A and C; D is the finishing activity. Draw CPM Network. Calculate points for PTC graph and plot the same. Determine the optimum cost and optimum duration for the project. PTC is Project-Time-Cost-Trade -Off graph. **[5 Marks]**

Sol. 7. (a) Network Diagram



Critical path = 1 – 2 – 3 – 4

Cost slope

Activity	Normal		Crash		Cost Slope		
	time	cost (Rs.)	time	cost (Rs.)	ΔC	Δt	ΔC/Δt
A	8	6000	4	12000	6000	4	1500
B	4	2000	2	14000	12000	2	6000
C	10	4000	4	8000	4000	6	666.67
D	6	4000	4	8000	4000	2	2000

Normal Cost at normal project duration

Normal project duration = 20 days

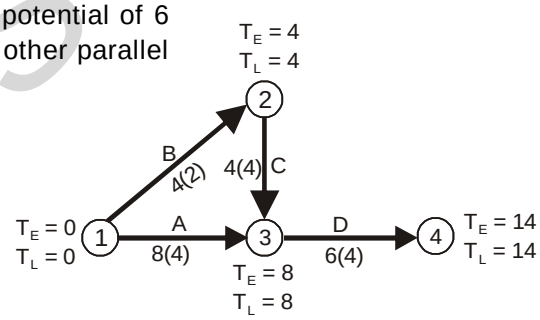
Direct cost = 6000 + 2000 + 4000 + 4000 = Rs. 16000

Indirect cost = 20 × 1000 = Rs. 20000

Total cost = 16000 + 20000 = Rs. 36000

First stage crashing

We can observe that among critical activities, activity C has minimum cost slope *i.e.* 666.67 and has crashing potential of 6 days. It can be crashed by 6 day without affecting other parallel activities.



New project duration = 14 days.

Direct cost = 16000 + 6 × 666.67 = Rs. 20000

Indirect cost = 14 × 1000 = Rs. 14000

Total cost = 20000 + 14000 = Rs. 34000

Second stage crashing

We can observe that, now we have 2 critical path A –D and B–C–D. Therefore we have to check various alternatives of combinations of cost slope

(i) C/S of B + C/S of A = 6000 + 1500 = 7500

(ii) C/S of D = 2000

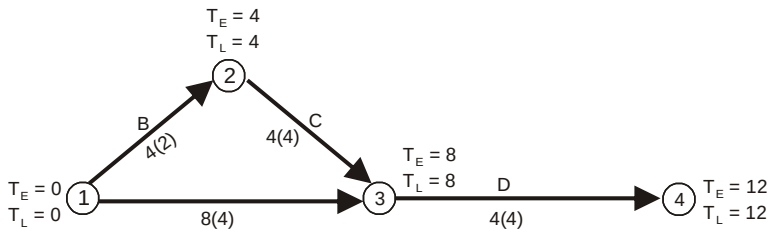
∴ Cost slope of activity D is minimum, therefore it can be crashed for its complete crashing potential that is 2 days.

New project duration = 12 days.

Direct cost = 20000 + 2 × 2000 = Rs. 24000

Indirect cost = 12 × 1000 = Rs. 12000

Total cost = 24000 + 12000 = Rs. 36000



Third Stage Crashing

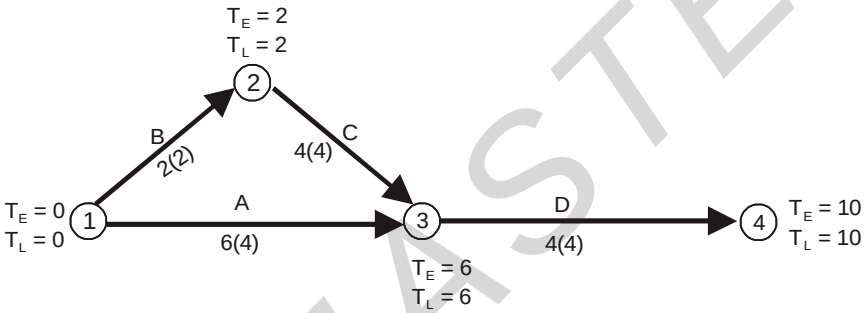
Now we can crash activity A and B simultaneously by 2 days. As these are parallel activities and crashing potential of activity B gets expired.

New project duration = 10 days.

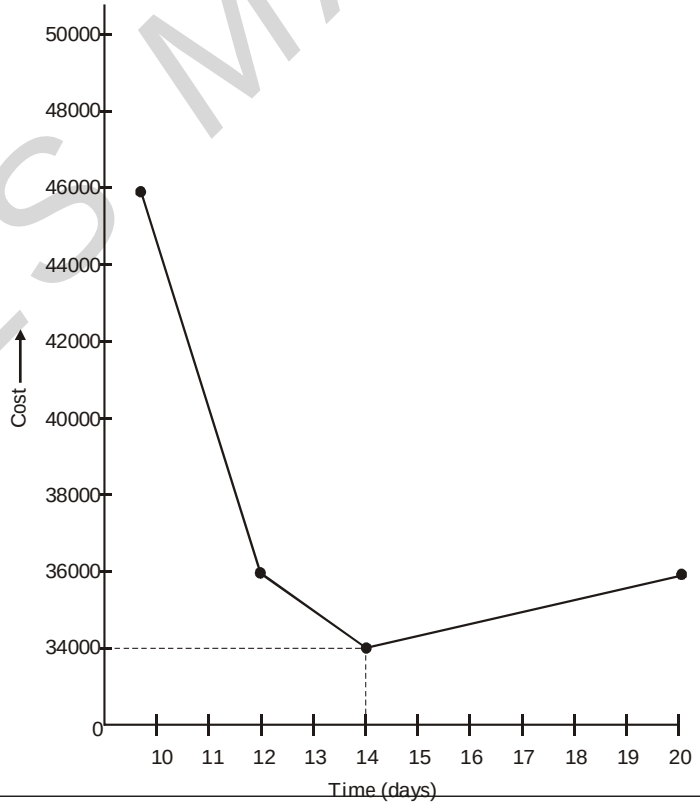
Direct cost = 24000 + 6000 × 2 = Rs. 36000

Indirect cost = 10 × 1000 = Rs. 10000

Total cost = 36000 + 10000 = Rs. 46000



Total Cost Curve:



Optimum project duration = 14 days

Optimum project cost = Rs. 34000

7. (b) Determine the output of a bulldozer for the following situations;

(a) Material handled sandy loam top soil having swell = 25%
(b) Haul distance = 30 meters
(c) Rated mould board capacity = 3 cum loose volume
(d) Actual operating time per hour = 45 minutes
(e) Forward speed 2.4 km per hour
(f) Reverse speed 6.0 km per hour. **[5 Marks]**

Sol. 7.(b)

If D = Haul distance (m), R = Reverse Speed (km/h), F = Forward speed (km/h), G = Time required for gear shifting (minutes).

Time required per trip in minutes (or cycle time) = $\frac{D}{F}+\frac{D}{R}+G$

$$= \frac{30}{\frac{2.4\times1000}{60}}+\frac{30}{\frac{6.0\times1000}{60}}+0.3$$

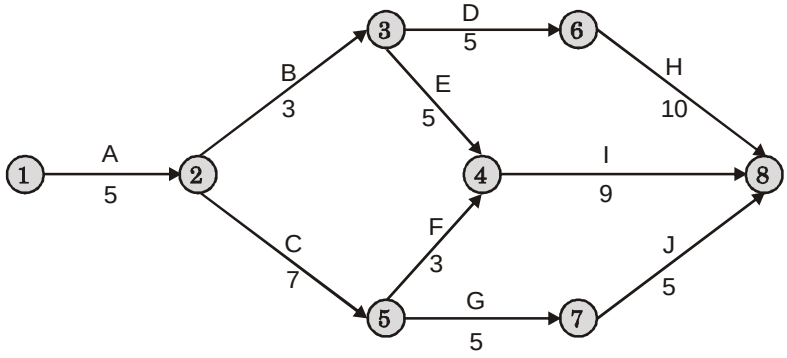
$$= 0.75 + 0.30 + 0.30 = 1.35 \text{ minutes}$$

$$\text{Output of bulldozer} = \frac{3}{1.25}\times\frac{45}{1.35}\text{cum/hr}$$

$$= 80 \text{ cum/hr.}$$

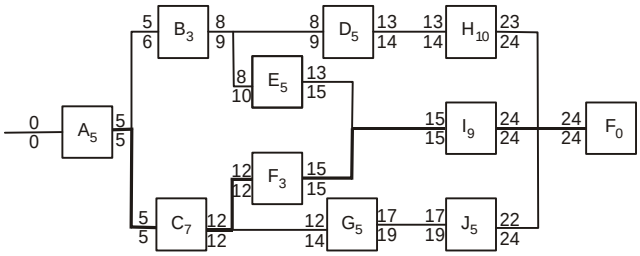
8. (a) For the given A-O-A network shown in fig, draw A-O-N network and find.

(i) EST, EFT, LST & LFT of each activity
(ii) TF of each activity
(iii) Critical path and project duration **[10 Marks]**



Sol. 8.(a)

A-O-N Network Diagram



Calculation of EST, EFT, LST, LFT and F_T are done in table below:

Activity	t^{ij}	EST	EFT	LST	LFT	TF	Remarks
A	5	0	5	0	5	0	Critical
B	3	5	8	6	9	1	
C	7	5	12	5	12	0	Critical
D	5	8	13	9	14	1	
E	5	8	13	10	15	2	
F	3	12	15	12	15	0	Critical
G	5	12	17	14	19	2	
H	10	13	23	14	24	1	
I	9	15	24	15	24	0	Critical
J	5	17	22	19	22	2	
Fo	0	24	24	24	24	–	

$\therefore$ Critical path along A – C – F – I.

$\therefore$ The project duration is 24 units.

8.(b) A construction work consists of activities with durations in days for a PERT network as given below:

Activity	P	Q	R	S	T	U	W	Y	Z
Predecessors	–	P, T	Q	–	S	–	S	S	U, W
t_o (in days)	3	4	4	3	8	1	2	4	6
t_m (in days)	6	8	5	3	14	4	5	7	15
t_p (in days)	9	9	9	3	17	7	14	13	30

Determine :

(i) The probability of completing the job in 32 days and

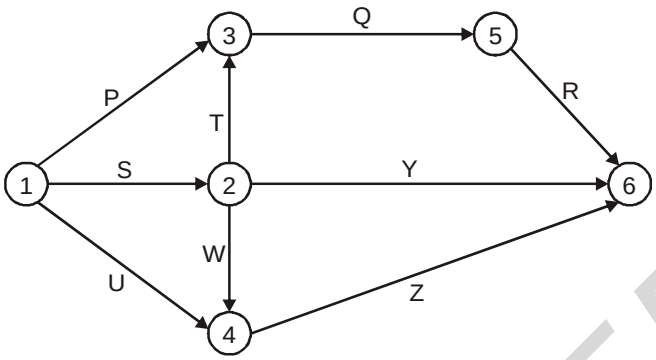
(ii) The completion time with 50% probability.

Z	–1.5	–1.3	–1.0
Probability	0.07	0.10	0.16

[10 Marks]

Sol. 8. (b)

Network Diagram

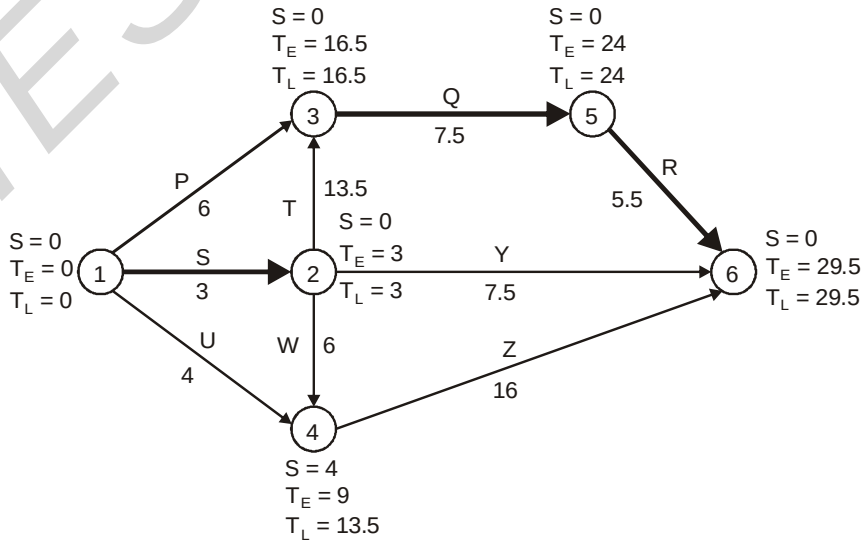


Calculation of T_E and σ has been done in table below:

where, $t_e = \frac{t_0 + 4t_m + t_p}{6}$, $\sigma = \frac{t_p - t_0}{6}$

Activity	t_o	t_m	t_p	t_e	σ
P	3	6	9	6	1
Q	4	8	9	7.5	0.83
R	4	5	9	5.5	0.83
S	3	3	3	3	0
T	8	14	17	13.5	1.5
U	1	4	7	4	1
W	2	5	14	6	2
Y	4	7	13	7.5	1.5
Z	6	15	30	16	4

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



As we can observe that Events 1, 2, 3, 5, 6 are having zero Slack.

∴ Critical path is 1–2–3–5–6/S–T–Q–R

Standard deviation along the critical path is , $\sigma = \sqrt{0^2 + 1.5^2 + 0.833^2 + 0.833^2}$ = 1.91 days

(i) $Z = \frac{T_S - T_E}{\sigma} = \frac{32 - 29.5}{1.91} = 1.31$

∵ if $Z = -1$ *then* $p = 0.16$ ∴ *if* $Z = 1$ *then* $p = 0.84$

∵ if $Z = -1.3$ *then* $p = 0.10$ ∴ *if* $Z = 1.3$ *then* $p = 0.90$

∵ if $Z = -1.5$ *then* $p = 0.07$ ∴ *if* $Z = 1.5$ *then* $p = 0.93$

∴ Probability for Z = 1.31

We will do interpolation = $0.90 + \left(\frac{0.93 - 0.90}{1.5 - 1.3}\right) \times (1.31 - 1.30)$ = 0.9015 = 90.15%

(ii) for p = 50 ® z = 0

Hence $T_E = T_L = 29.5 = T_S$.