Civinnovate

Discover, Learn, and Innovate in Civil Engineering

*) Classification of project:

1) According to sources of fund:
   (a) Private project (b) Government project
   (c) Grant+ (अनुदान) " (d) Loan (ऋण) "

2) Foreign Aided project:
   a) Joint venture project: दुई वा दुई भन्दा बढी company. foreign+Nepal
   b) Bilateral " : KOICA, JICA, DFID, GTZ.
   c) Multilateral " : ADB, WB, EU, OPEC, etc.

3) According to Technique:
   a) labour intensive - excessive use of labour
   b) Capital intensive - excessive use of tools & equipments
      (Bhein Babai - TBM used)

4) According to Scale:
   (a) Mega (b) Major (c) Medium (d) Small
   (e) Micro (f) Pico (Hydro: 1 KW - 1,000 Watt?)

5) According to Orientation:
   a) Product oriented - Building, road, hydro, water supply, etc.
   b) Process oriented - Training, Seminar, etc.

6) According to Time frame & Speed:
   a) Normal -
   b) Crash - To be completed in shorter period by using excessive resources/efforts.
   c) Disaster - Project for emergency relief works, after landslide, earthquake, flood, etc.

*) Disadvantages of Labour intensive project:

→ Project runs at slow pace.
→ Unsafety to the workers.
→ Expensive for Mega projects and sometimes impossible to complete.
→ Heavy manpower required.
→ Unmanaged workers, effected by strike, climatic factors.

*) Advantages of Labour Intensive project:

- Job opportunity
- Environment friendly
- Less initial investment
- Less skilled manpower.
- Cost effective on small projects
- Less effect due to shortage of fuels, etc.

*) Advantages of Capital intensive projects:

- Working speed is fast
- Less manpower required
- Efficiency of work is high.
- Difficult project can be easily carried out.
- Single investment on instrument can be beneficial for multiple project.
- Operating cost is low.
- No. of works can be carried out at a time continuously.
- Best where manpower isn't sufficient.
- Beneficial for big project.

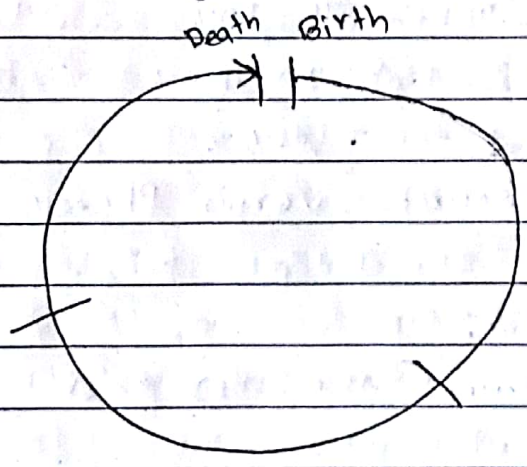
*

transfer ↑

*) Disadvantages of Capital Intensive project:

- Less employment opportunity.
- High initial cost.
- Skilled manpower required.
- Environmental pollution.
- excessive use of non-renewable energy.
- Risk of accidents.
- Difficult to transport equipments/import equipments.

*) Project phases/ lifecycle of project:

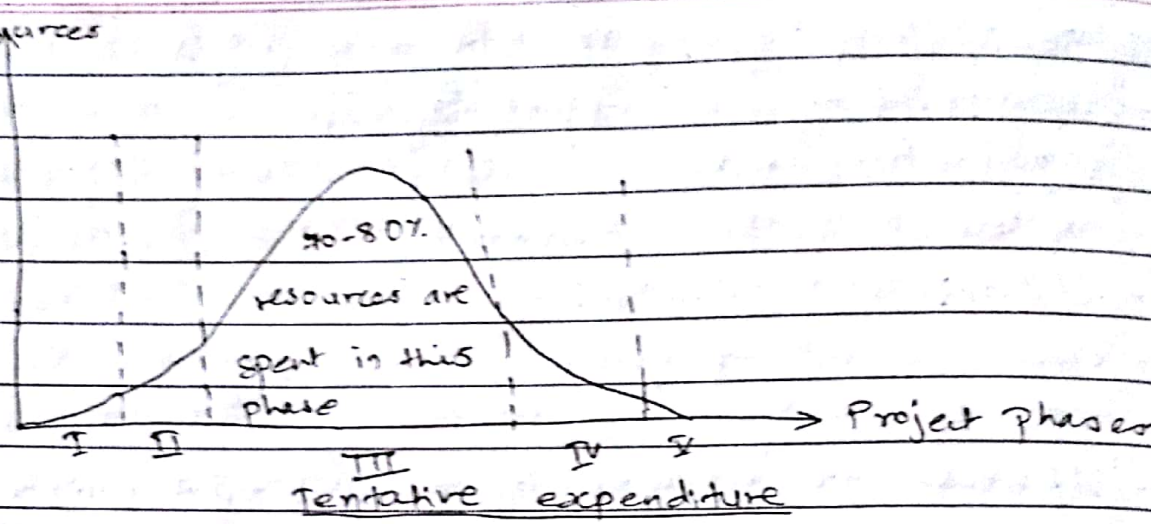


1) Pre-Construction	→	1) Conceptual planning	1) Initiation
		2) Definition	2) Planning
2) Construction	→	3) Implementation	3) Implementation
3) Post-Construction	→	4) Operation	
		5) Phase out	4) Phase Out

*) A list of activities carried out in preconstruction phase of civil engg. projects:

- Recce
- Preliminary Survey
- Detail survey
- Design
- Tender bidding documents prepare
- Analysis
- Tests to be carried out
- feasibility
- site clearance & land acquisition
- Appointment of specialist consultant.

1:1:2 → M25

*> 

I - Conceptual planning — 1-2%
II - Definition — 5-10%
III - Const^n / Implem^n - 70-80%
IV - Operation - 10-20%
V - Termination - 2-5%

Fig: Resources versus Phases

*> Project environment:

1> Internal environment 2> Task ,,

3> External ,,

3)-> External environment includes:

a) Political & legal environment:

b) Economic envt: $, inflation,

c) Socio-cultural envt:

d) Technological envt:

2>> Task Environment (Stakeholders):

a) Client b) Contractor c) Consultants

d) Financial Institutions e) Suppliers f) Government

g) Media, ~~etc.~~ h) Community (Local bodies), ~~etc.~~ i) Competitors

1)-> Internal environment:

a) Objectives b) Resources c) Structure

d) Constraints

3) Popn = 500 Nos, 1.5% p.g.a, 20 yrs.

Poph after 20 years = $500 \times \left(1 + \frac{1.5}{100}\right)^{20}$ = 673.43 Nos.

Required supply = 673.43 × 45 lpcd = $\frac{673.43 \times 45}{24 \times 3600}$ = 0.35 lps.

*> Project Management:

Project formulation

*> Appraisal: It is the evaluation of overall ability of the project to succeed. It is the process of accessing and questioning proposals before committing resources. The objective of project appraisal is to study and compare the possible feasible projects and select the best one. It answers following questions:

a) ~~How~~ Will the project meet its objectives?

b) How does the project compare with other competing projects?

Appraisal is done systematically to provide an overall assessment of the likelihood for success. The institution that is going to fund the project has to satisfy itself before financial assistance.

Project appraisal is the indepth study of feasibility study which includes:

a) Technical analysis
b) Economic " : PBP/NPW/IRR/BCR
c) Financial "
d) Marketing "
e) Institutional (~~Marketing~~ Management) "
f) Environmental "

*> Technical analysis of highrise building:

1) Bearing capacity of soil/settlement
2. Uplift due to earthquake & prevailing winds
3. Floor area (total)
4. Type of the ~~place~~ region (zone)
5. ~~Usefulness~~ Effectiveness to society
6. Obstruction to society
7. Size & stress in structural elements
8. Cultural & religious aspect
9. Ground water condition
10. Limiting height of building w.r.t. Stability

*> Project proposal: It is the document designed to present a plan of action, outline the reasons why the action is necessary and convince the reader to agree with and approve the implementation of the actions recommended in the body of action.

Contents of project proposal:

1. Technical proposal: It gives technical details and descriptions of the project which includes.

a. Problem statement: Description of the project problem.
b. Special requirements: Any special requirements as specified in TOR (Terms of References).
c. Test & Inspections: Procedures related to testing, quality assurance, reliability & compliance along with specification.
d. Logistics: Details of facilities, equipments, skills, & administrative aspects.
e. Reporting: format, timing, nature of reporting.
f. CV: CV of key personnel for execution of the project.
g. Capacity statement: Experience of the form, key experience, manpower, equipments, etc.

2.) Financial proposal: It deals with the financial details which includes:

a. Items of works to be covered / materials, etc.
b. Rate Analysis
c. Cost Estimates as per TOR.

*) Water Supply, Sanitation & Solid Waste Management in Pyuthan:

Proposal:

To: JICA, Nepal

From: SWORGADWARI MUNICIPALITY

Objective: Request to support Health & Sanitation project in the municipality

Contents:

1) Technical proposal

a. Problem Statement: This municipality lacks the proper drinking water supply. The villagers rely directly on the river flowing on the west of SWORGADWARI municipality. According to the recent census, the total population is approximately 16,600. Due to ~~this~~ the lack of proper w/s, the villagers also lack proper sanitation. ~~Only 8% of the people use proper & air latrine~~ 87% of the people use open defaecation. ~~latrine~~. As it is an important place from religious point of view, it should be keep clean. It is also getting worse as people throw their solid wastes at any open places. So, this project is a must for this municipality.

b. Special requirement: As the river water contains high amount of calcium, certain chemical ~~examinations~~ treatment need to ~~should~~ be carried out. For this certain equipments are needed.

c. Test & Inspections: The water quality should be tested in detail for supply. The RL should also be measured for ~~its~~ the possibility of the project.

d. Logistics:

*> Project formulation: Technique:

Hydropower project: 1 MW = 20 crore

Q40 ⇒ 40% of 12 month ≈ 5 months, high capacity

Build = 5 yrs. Operate = 30 years

Cost = 20, 6 crore SV = 0

N = 30 years

Income = (1000 KW x 1 hr) 24 x 365 units/year x 0.6 x $\frac{4.9+8.4}{2}$ = 3.154 crore/yr

O&M = 2% of 20, crore = 40 lakhs/year

MARR = 14 %

IRR = ?

Now,

$PW(i\%) = 0$

or, $-20,00,00,000 + 2,75,48,000 (P/A, i\%, 30) = 0$

or, $-20,00,00,000 + 2,75,48,000 \times \frac{(1+i)^N - 1}{i(1+i)^N} = 0$

$\therefore i = 13.46\%$

*> Techniques of project formulation:

1> Feasibility Analysis → Technical, etc

2> Cost Benefit Analysis:

a. Estimation of costs (first cost & Annual cost)

b. Estimation of Benefits.

c. " " Project period

d. " " Interest Rate (MARR, i)

e. " " Salvage value (if any).

To determine the viability, finding PB period, NPV, IRR, BCR etc

3> Input Analysis:

- It makes the analysis of human & non-human resources required for the project.
- Human resources analysis includes acquisition, utilization,

development, & maintenance of workforce as well as job descriptions.

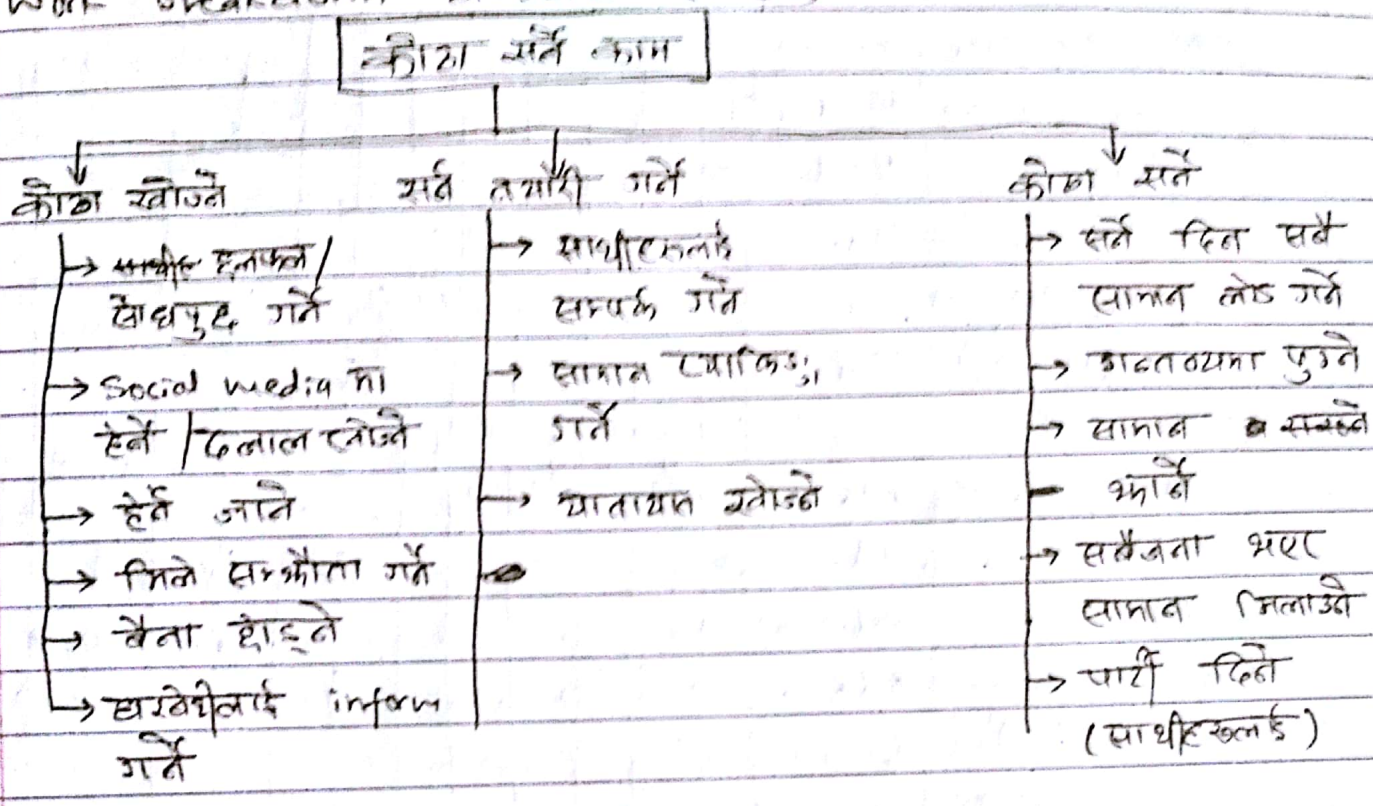
- Non-human resources includes equipment, material, their supplies, quality, etc. (TBM??)

4) Environmental Analysis: includes
IEE or EIA

- Small projects: Initial Environmental examination.
- Large projects: Environmental Impact Assessment.
It analyses the possible impacts, its consequences & recommend mitigation measures before implementation of the project.

Ch-3 × Project × Planning & Scheduling ×

*> Work Breakdown structure (WBS)



*> BAR CHART (Gantt chart):

It is a pictorial representation of project activities by Horizontal Bars in Time Axis. It was developed by Henry Gantt in 1900 AD, hence also called Gantt chart in his respect.

It shows:

1. Project start date, Duration and finish Date.
2. Activity start date, " " " ".

Length of bar ∝ Activity Duration

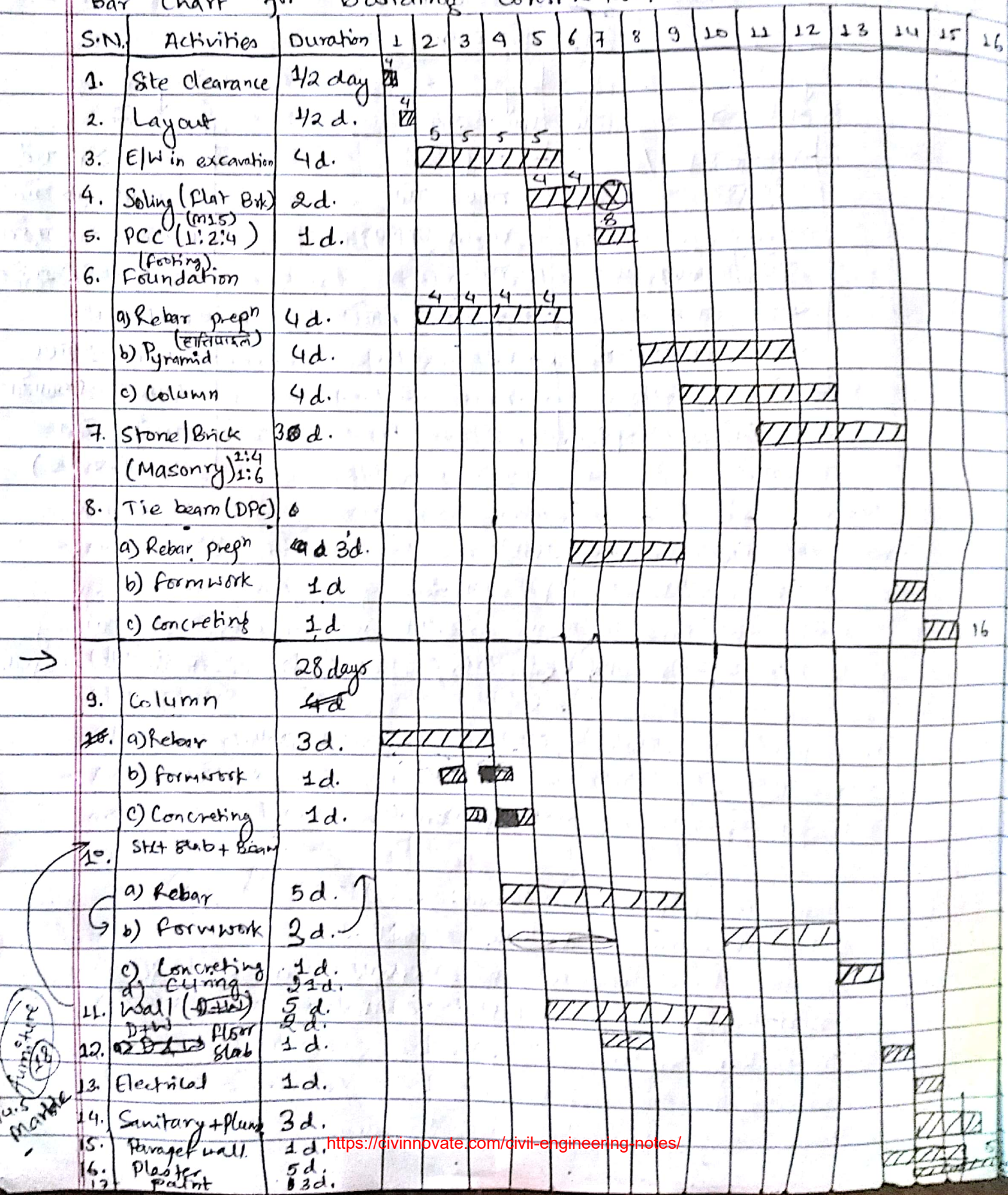
Steps in preparing Bar chart:

1. List out activities to be carried out.
2. Estimate time required to complete each activity.
3. Establish Relationship beth activities.
4. Draw Bar charts.

×2 → wall

35.3 (m^3) = 26.8md

Bar Chart for Building Construction:



*> Advantages of Bar Chart:

~~18 19 20 21~~

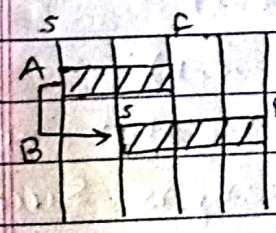
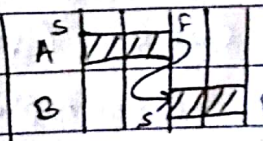
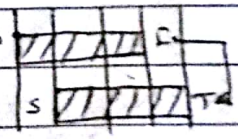
1. Easy to prepare and understand.
2. Can be used to show progress.
3. Can be used to prepare resource schedule.
4. Gives clear pictorial view of the project.

*> Limitations of Bar Chart:

1. Useful for simple and small projects.
2. Doesnot clearly show the relationship between activities clearly.
3. Doesnot show critical path, critical activities, floats, etc.
4. Due to lack of special indication in chart, long duration activity seems most important.
5. Difficult to make changes/corrections if there are many changes.

*> Linked Bar chart:

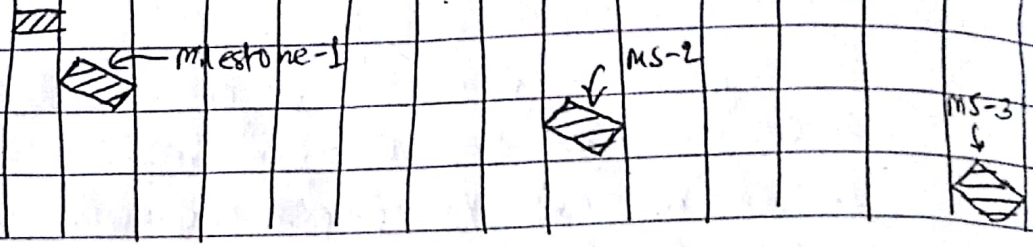
If relationship between activities are shown by arrow or link in Grantt chart, it is called linked Bar chart. Link can be:

		
Start B one day after starting A START TO START	Start B immediately after finishing A FINISH TO START	finish A first and finish B (one day after) FINISH TO FINISH

*> Milestone Chart:

Milestones are the important events in project. If milestones are shown by special indications in Gantt chart it is called milestone chart.

S.N.	Activities	Duration	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Site clearance	1														
2.	पिलरथाप	1														
3.	ढलान	1														
4.	उपलाउन	1														



*> Critical Path Method (CPM):

→ It is a network based tool for scheduling project developed by R. Morgan for Repair and Maintenance of DuPont Chemical factory, USA in 1957 AD.

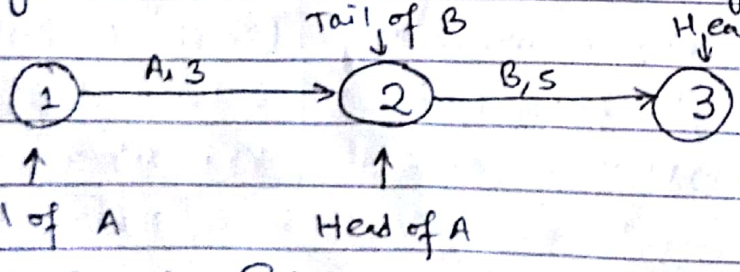
→ It uses arrow (→) to represent activity where length of arrow has no relationship with activity duration.

→ Start & end of activity is known as EVENT. starting event is tail event and ending event is head event.

→ An event which is head event of an activity & tail event of another activity is DUAL ROLE EVENT.

E/W in excavation ⟶ Activity (Time & Resources)
E/W started ⟶ EVENT (Tail event)
E/W completed ⟶ EVENT (Head event)

→ An activity which must be completed to start new activity is Predecessor & Following activity is Successor.



(2) is Dual Role Event.
A is Predecessor of B.
B is Successor of A.

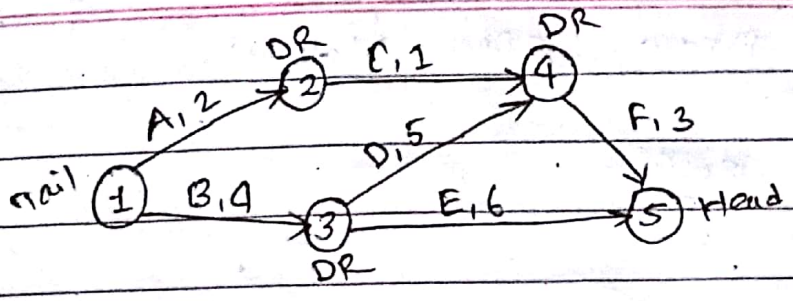


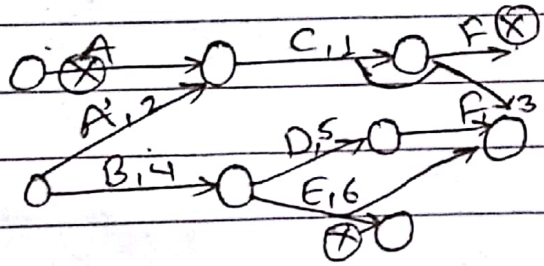
Fig: CPM Network

In CPM (MCQ):

a) A > E
b) A = E
c) A < E
d) All ✓

Activity = 6
Event = 5

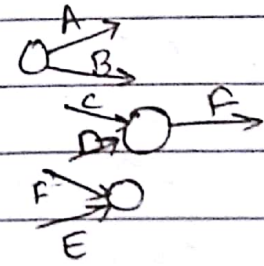
Activity	Duration	Predecessor	Successor
A	2	—	C
B	4	—	D, E
C	1	A	F
D	5	B	F
E	6	B	—
F	3	C, D	—



Rule 1: only one starting event.

Rule 2: One activity, one arrow.

Rule 3: Only one ending event.



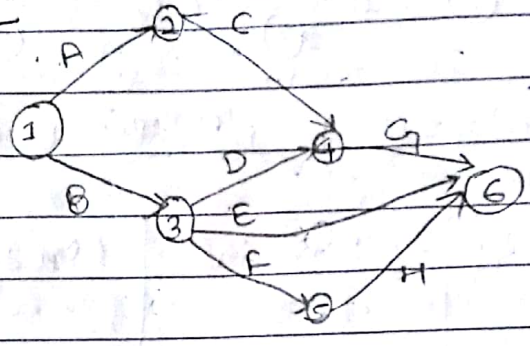
James Funkerson Rule of Numbering event:

Draw CPM Network:

Q) Draw CPM Network!

Act.	Pred.	Suc.
A	—	C
B	—	D,E,F
C	A	G
D	B	G
E	B	—
F	B	H
G	C,D	—
H	F	—

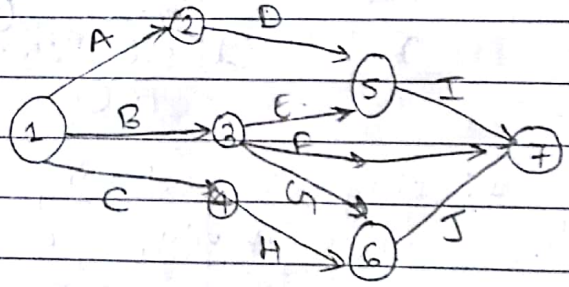
Soln!



Q) Draw CPM Network!

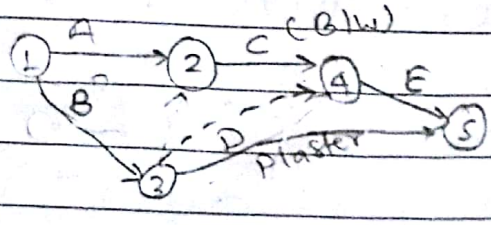
Act.	Pred.	Suc.
A	—	D
B	—	D,E,F,G
C	—	H
D	A	I
E	B	I
F	B	—
G	B	J
H	C	J
I	D,E	—
J	G,H	—

⇒ Soln!



Q)

A	—	C
B	—	D,E (odd)
C	A	E
D	B	—
E	B, C (odd)	—

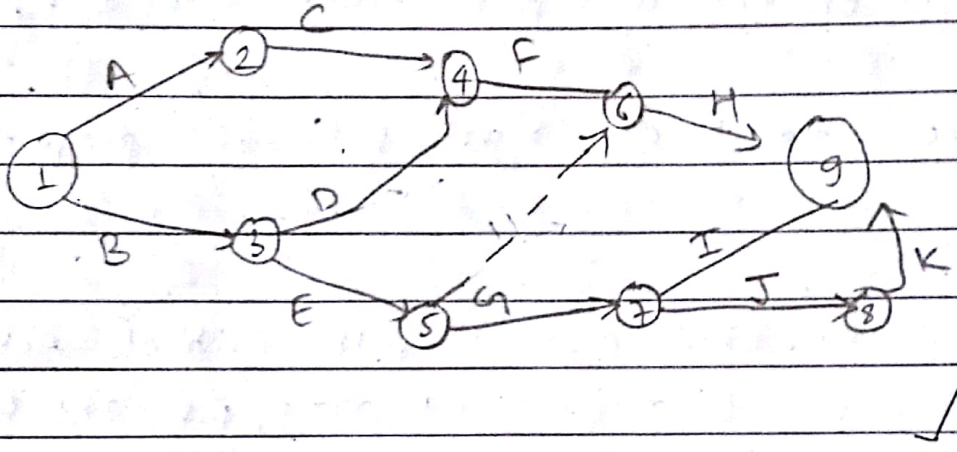


A/B transf → C (B/w) → dummy activity (dotted)

B (mortar) → D (Plaster)

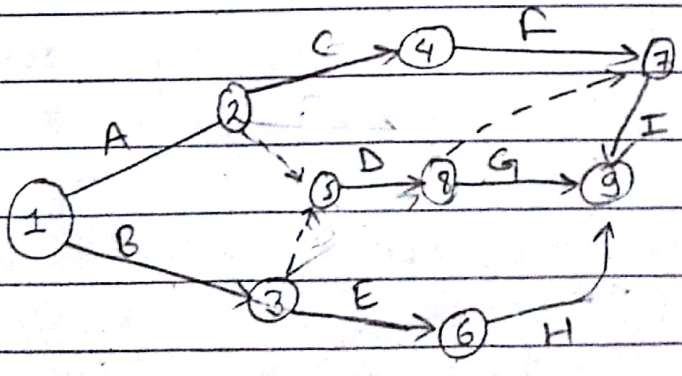
Act:	A	B	C	D	E	F	G	H	I	J	K
Pred.	—	—	A	B	B	C, D	E	E, F	G	G	J
Suc.	C	D, E	F	F	G, H	H	I, J	—	—	K	—

Soln:



Act:	A	B	C	D	E	F	G	H	I
Pred:	—	—	A	A, B	B	C	D	E	D, F
Suc:	C, D	D, E	F	G, I	H	I	—	—	—

Soln:



*) For qn 1:

① → ⑤ पुरन

1: ① — ② — ④ — ⑤ : 6d

2: ① — ③ — ④ — ⑤ : 12d

① — ③ — ⑤ : 10 d.

→ Longest path is Critical path → 2 (1-3-4-5).

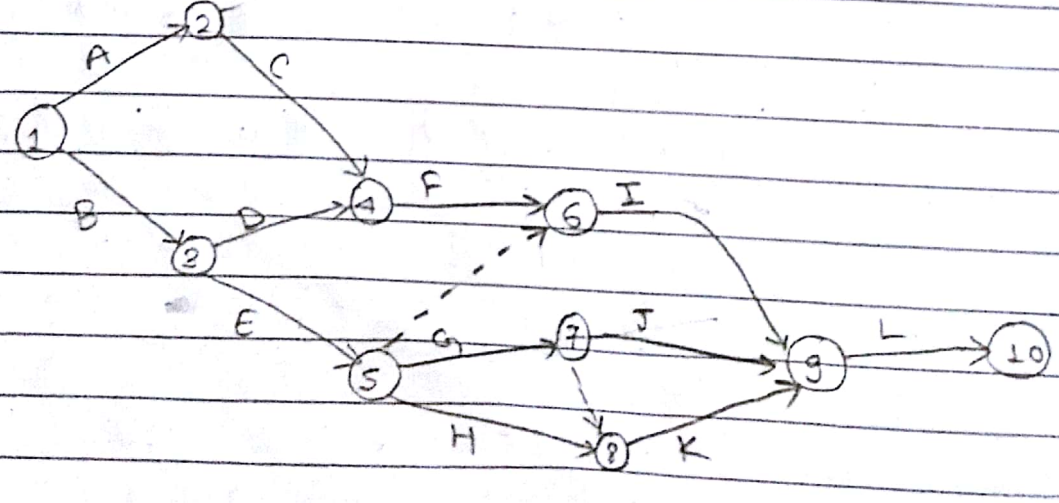
→ Activity lying on critical path are B, D, & F, are critical activities.

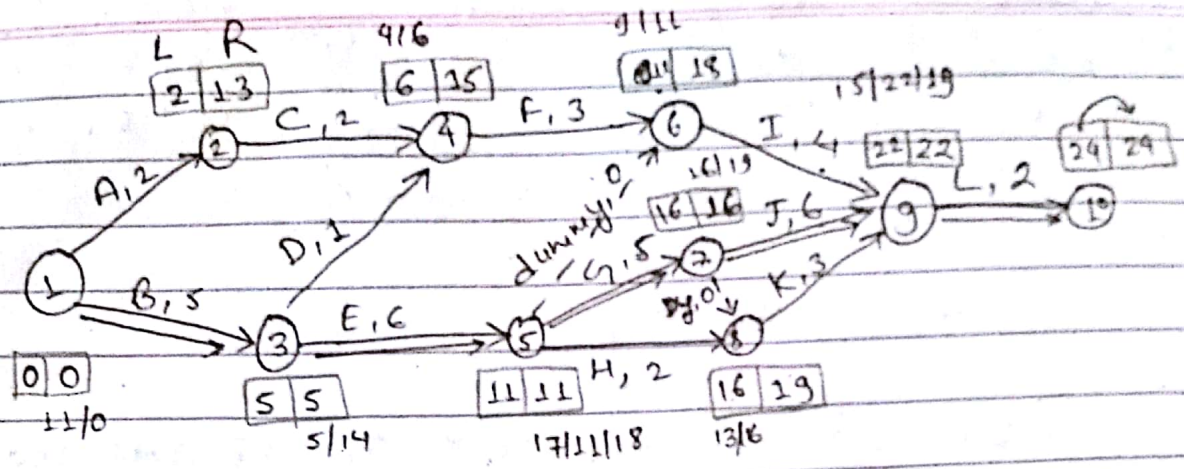
→ Time required to travel longest path is project duration = 12 days.

*) Draw CPM network. Find critical path, Critical Activities, Project Duration, EST, EFT, LST, LFT, TF, FF, Int F, Ind F.

Act.	A	B	C	D	E	F	G	H	I	J	K	L
Dur.	2	5	2	1	6	3	5	2	4	6	3	2
Pred.	X	X	A	B	B	C,D	E	E	E,F	G	G,H	I,J,K
Succ.	C	D,E	F	F	G,H,I	I	J,K	K	L	L	L	X

⇒ Soln:





Forward Pass Calculation

① → Left part of the box → 0 लेकर चले

→ Duration add करते left part में जाते

→ Take maximum value, if two or more comes in the process.

→ Continue till the end (Last event)

Backward Pass calculation:

→ Start with last event, where L = R value (Put)

→ Deduct duration (right to left).

→ Take minimum value, if two or more values comes in the process.

→ Continue till the first event (0 आना चाहिए)

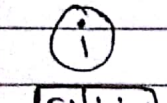
⇒ R ≥ L

L = R वाले जोड़ते जाना critical path आता है।

So, critical path is: ①–③–⑤–⑦–⑨–⑩.

Activities lying on critical path are critical activities which are B, E, G, J & L.

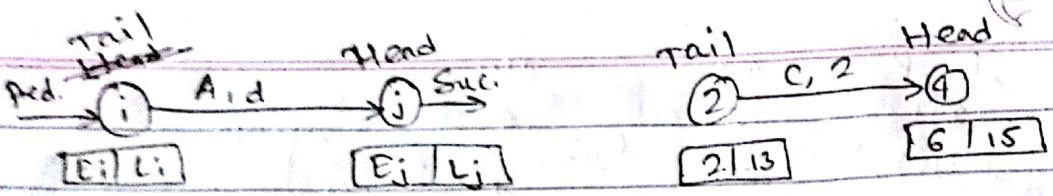
Project duration = 24



Ei → Early Event time

Li → Late " "

Li ≥ Ei



Ei → Early start time EST of Activity

EST of C = 2 – 3rd day

EST of A = 0 – 1st day.

Activity	Dur	EST	EFT	LST	LFT	TF	FF	IntF	IndF	Remarks
A	2	0 → 2		11 ← 13		11	0	11	0	
B	5	0 → 5		0 ← 5		0	0	0	0	Cr
C	2	2 → 4		13 ← 15		11	2	9	-9	
D	1	5	6	14	15	9	0	9	0	
E	6	5	11	5	11	0	0	0	0	Cr.
F	3	6	9	15	18	9	2	7	-7	
G	5	11	16	11	16	0	0	0	0	Cr.
H	2	11	13	17	19	6	3	3	-3	
I	4	11	15	18	22	7	7	0	0	
J	6	16	22	16	22	0	0	0	0	Cr.
K	3	16	19	19	22	3	3	0	0	
L	2	22	24	22	24	0	0	0	0	Cr.

EFT : Early finish time = EST + duration

Lj : Late finish Time LFT of Activity

LFT of C = 15

LST : Late start time = LFT – Duration

TF : Total Float: Duration by which an activity can be delayed without delaying project

= LST – EST or LFT – EFT

= 0 for critical activity

TF = Lj – Ei – d

TF of C = 15 – 2 – 2 = 11

MCQ: $L_j - E_j$ = Event slack of Head Event
$L_i - E_i$ = " " " Tail Event

→ Free Float: Duration by which an activity can be delayed without delaying Early start time of Successor.

$FF = E_j - E_i - d$

FF of C = 6 − 2 − 2 = 2

$FF \leq TF$

MCQ:
a) FF > Int. f
b) FF < Int f
c) FF = Int f
d) All

→ Interfering float = TF − FF
$= (L_j - E_i - d) - (E_j - E_i - d)$
$= L_j - E_j$
= LFT of Act − EST of Succ.

Independent float:
$= E_j - L_i - d$
$= \leq FF$
= EST of Succ − LFT of Pred. − d

MCQ:
Ind. float
a) -ve आ सकता है।

*> Draw CPM Network. Find critical path, critical activities, project duration, EST, EFT, LST, LFT, TF, FF, Int F, Ind F. Use

*> PERT: Program Evaluation & Review Technique:

It is also network based technique (like CPM) developed by US Navy for scheduling Polaris Missile Project (Launching Nuclear Missile from submarine) in 1956 AD.

It is used for Novel projects like Research and Development (R&D) where it is difficult to estimate activity duration accurately.

It uses three (3) time estimates for activity duration.

a) Optimistic Time (to): Minm time required to complete the activity in ideal/favourable condition. (4y-0m)

b) Pessimistic Time (tp): Maxm time reqrd to complete the activity in worst activity. (4y-8m)

c) Most likely time (tm): Time reqrd to complete the activity in normal situation. (4y-3m)

From these time estimates, we calculate Average Time (μ) or expected time (te) using:

$$te \text{ or } \mu = \frac{to + 4tm + tp}{6}$$

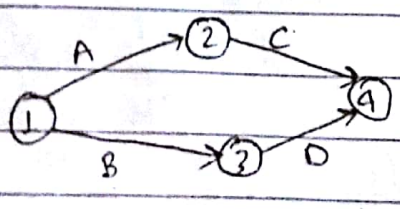
where, probability of occurrence of $to = \frac{1}{6}$, $tm = 4/6$ and $tp = 1/6$.

Similarly, we calculate:

Standard deviation, $S_d = \frac{tp - to}{6}$

& variance, $v = S_d^2 = \left\{\frac{tp - to}{6}\right\}^2$

} using β-distribution.



	to	tm	tp	te/μ
A	2	3	5	3.16
B	2	5	14	6
C	4	7	10	7
D	4	10	16	10

1-2-4 : 3.16 + 7 = 10.16 D.

1-3-4 : 6 + 10 = 16 D (Avg). (Project Duration)

1-3-4: Min^M: B-2+D-4 = 6 days

Max^M: B-14+D-16 = 30 days

< 6 days ⇒ p = 0

≥ 30 days ⇒ p = 1

→ p for 16 days = (0-1)

Prob. factor $(z) = \frac{x - \bar{x}}{\sigma}$

z → +ve → > 0.5

z → -ve → < 0.5

$\bar{x}$ = 16 (mean), x = 16 (given) ⇒ z = 0.

→ x = 20

$\sigma_B = \frac{t_p - t_o}{6} = \frac{14-2}{6} = 2$

$\sigma_D = \frac{16-4}{2} = 2$

σ_{A+B} = a) $\sigma_A + \sigma_B$ c) Both

b) $\sqrt{V_A + V_B}$ d) None

$V_{A+D} = V_A + V_B$

But, $\sigma_{A+B} \neq \sigma_A + \sigma_B$

*> Differences between CPM and PERT?

→ Both network based techniques, developed in USA in 1956/57 AD.

CPM → Dupont chemical works factory repair & maintenance used.

PERT → Polaris Missile Project.

CPM	PERT
→ Having previous experience like engineering.	~~Having~~ Novel projects like R&D.
→ Single time estimate.	Three time estimate for activity durn.
→ Deterministic approach.	Probabilistic approach.
→ Activity oriented.	Event oriented.

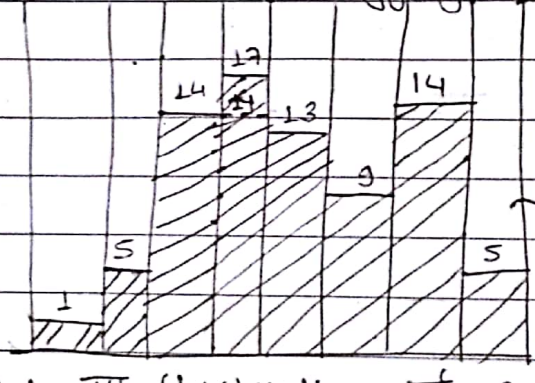
✱ Resource Levelling | Smoothing:

Resource Schedule

- Schedule : Something vs time
- Resource vs time

S.N.	Activity	Durn	1	2	3	4	5	6	7	8	Labour
1	A	2	1	15	Loading						2
2	B	3		4	4	4					12
3	C	5			6	6	6	6	6		
4	D	4				3	3	3	3	3	
5	E	3				4	4	4			
6	F	2							5	5	
Unsk. Lab.			1	5	14	17	13	9	14	5	→ Unskilled Labour's Schedule

Add गर्ने Process : Resource Aggregation



→ Resource Histogram

minᵐ : 1

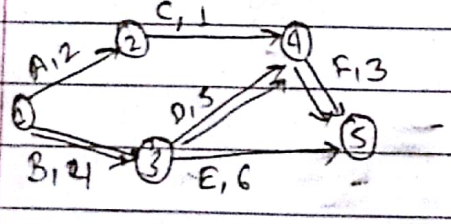
Maxᵐ : 17

Resource Schedule मा fluctuation लाई Reduce गर्ने Process लाई Resource Levelling भनिन्छ।

→ Duration increase नगरेन भने Resource Smoothing.

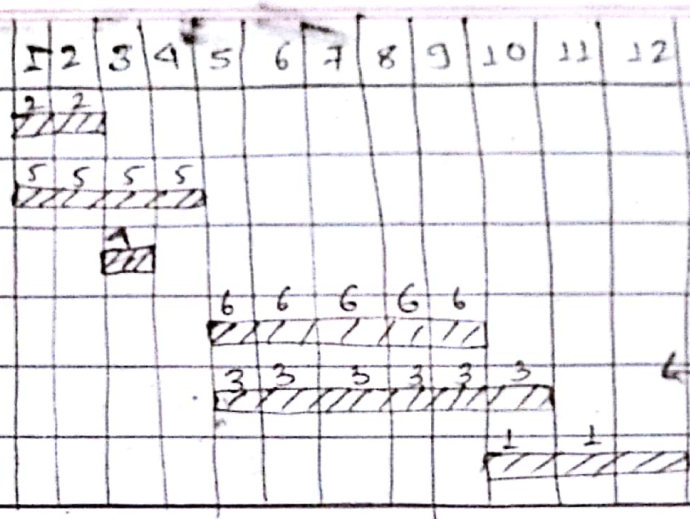
→ Duration increase गर्यो भने Resource Levelling.

Q) Prepare resource Schedule:



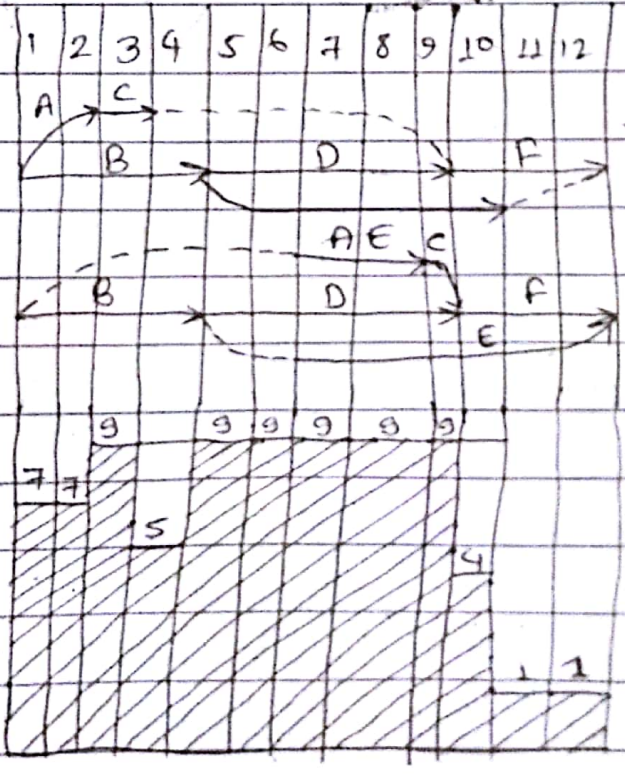
S.N.	Activity	Manpower (Mason) / day	Cement (Per day)	(bag)
1	A	2	20	10
2.	B	5	60	15
3	C	4	–	–
4	D	6	30	6
5	E	3	120	20
6	F	1	4	1.33

S.N.	Act.	Durⁿ:
1	A	2
2	B	4
3	C	1
4	D	5
5	E	6
6	F	3



same

Mason's schedule: 7 7 9 5 9 9 9 9 9 4 1 1



EST ≠ EFT

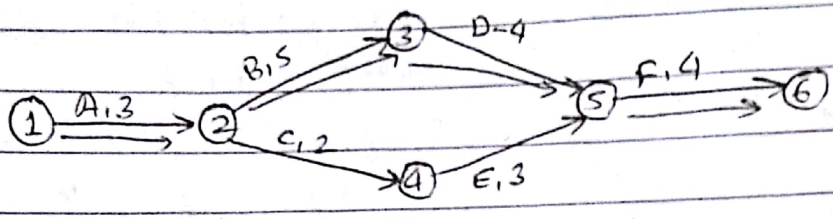
Or: EST = LST

EFT = LFT

Different

LST ≠ LFT

*> Prepare Early start and late start Schedule with following details:



Act.	Plumber/day	Bricks (Nos)	BK/day
A	2	3000	1000
B	1	10,000	2000
C	4	—	—
D	3	—	—
E	0	6000	2000
F	5	20,000	5000

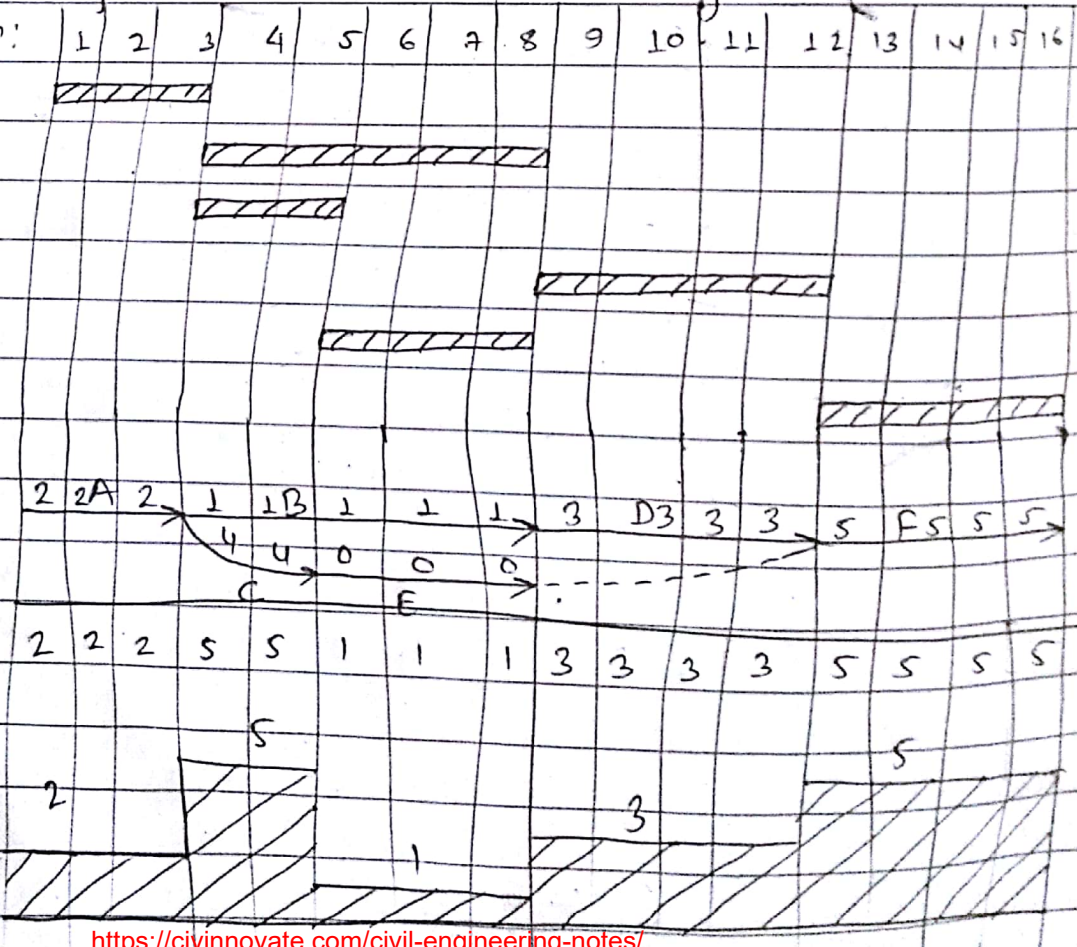
=> Soln:

~~S.N. Act. Durn~~ Critical path: ① - ② - ③ - ⑤ - 6

Early Start Schedule; Project durn: 3+5+4+4 = 16 days

S.N.	Act.	Durn:
1	A	3
2	B	5
3	C	2
4	D	4
5	E	3
6	F	4

Act Needed



Plumber Histogram

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