Engineering MANAGEMENT

Q) What is management? Explain ~~their~~ various ~~(performed)~~ transformations process.

OR

Tasks performed by employees.

Unit-I

Planning

Forecasting

Q) Define forecasting. Explain briefly quantitative methods

OR

Quantitative techniques

Quantitative Techniques

Q1) If the sales for the year 2017, 2016, 2015, 2014, and 2013 were ~~is~~ ₹3200, ₹3000, ₹2400, ₹2600 and ₹2,200 (values are in crores) respectively; what ~~(do we)~~ would be the sales for the year 2018 (if) using

1) Naive method
2) Simple Moving average method
3) 2-years moving average method

4) Weighted average method, if weights assigned is 0.4, 0.3, 0.2, 0.05 and 0.05 starting from the resale past years.

5) Exponential Smoothing method,

if (a) $\alpha = 0.3$

(b) $\alpha = 0.6$

6) Simple Linear regression method

Year	Sales
2013	2200
2014	~~3000~~ 2600
2015	2400
2016	3000
2017	3200

1) using naive method

~~Forecast (2018) = ₹3200~~

[what happens in the very previous year same happens here]

$F_{2018} = \cancel{₹3200}$ ₹3200

2) Simple Average method

$$F_{n+1} = \frac{1}{n} \sum_{t=1}^{n} A_t$$

$$F_{2018} = \frac{₹3200 + ₹3000 + ₹2400 + ₹2600 + ₹2200}{5}$$

$= ₹2680$

3) 2-years moving average

3 years	Year	Actual	Forecast (F_n)
—	2013	2200	—
—	2014	2600	—
—	2015	2400	$\frac{2200+2600}{2} = 2400$
$\frac{2200+2600+2400}{3} = 2400$	2016	3000	$\frac{2600+2400}{2} = 2500$
$\frac{8000}{3} = 2666.66$	2017	3200	$\frac{2400+3000}{2} = 2700$
$\frac{8000}{3} = 2666.66$	2018	—	$\frac{3000+3200}{2} = 3100$

(first 2 years nothing to calculate)

(take prev two)

4) Weighted average method

$$F_{n+1} = \sum_{t=1}^{n} W_t \cdot A_t$$

where, $\sum_{t=1}^{n} W_t = 1.0$

$\therefore F_{2018} = (2200 \times 0.05) + (2600 \times 0.05) + (2400 \times 0.2) + (3000 \times 0.3) + (3200 \times 0.4)$

$= ₹2900$

5) Exponential smoothing method

$$\boxed{\begin{aligned} F_{n+1} &= F_n + \alpha(A_n - F_n) \\ &= \alpha A_n + (1-\alpha)F_n \end{aligned}}$$

(a) if $\alpha = 0.3$ and
(b) if $\alpha = 0.6$

[To start the forecast sequence consider the actual sales of the very first year (A_{2013}) as the forecast value of the immediate next year.]

Year	A_t	(a) F_n if $\alpha = 0.3$	(b) F_n if $\alpha = 0.6$
2013	2200	–	–
2014	2600	2200	2200
2015	2400	2320	2440
2016	3000	2344	2416
2017	3200	2540.8	2766.4
2018		2738.56	

$\therefore F_{2015} = (0.3 \times 2600) + (0.7 \times 2200) = ₹\,2320$
$F_{2016} = (0.3 \times 2400) + (0.7 \times 2320) = ₹\,2344$
$F_{2017} = (0.3 \times 3000) + (0.7 \times 2344) = ₹\,2540.8$
$F_{2018} = (0.3 \times 3200) + (0.7 \times 2540.8) = ₹\,2738.56$

Date

$F_{2015} = (0.6 \times 2600) + (0.4 \times 2200) = ₹\,~~3760~~\,2440$
$F_{2016} = (0.6 \times 2400) + (0.4 \times 2440) = ₹\,2416$
$F_{2017} = (0.6 \times 3000) + (0.4 \times 2416) = ₹\,2766.4$
$F_{2018} = (0.6 \times 3200) + (0.4 \times 2766.4) = ₹\,3026.56$

6) Simple Linear Regression Model

Simple Linear Regression Model assumes that the dependent variable (y) depends on an independent variable (x), then the simple linear regression equation of 'x' on 'y'

$$y = a + bx$$

Then, $$b = \frac{n \cdot \Sigma xy - \Sigma x \cdot \Sigma y}{n \cdot \Sigma x^2 - (\Sigma x)^2}$$

and

$$a = \frac{\Sigma y}{n} - b \cdot \frac{\Sigma x}{n}$$

$$a = \bar{y} - b\bar{x}$$

Year	x	y	xy	x^2
2013	1	2200	2200	1
2014	2	2600	5200	4
2015	3	2400	7200	9
2016	4	3000	12000	16
2017	5	3200	16000	25
$n = 5$	$\Sigma x = 15$	$\Sigma y = 13400$	$\Sigma xy = 42600$	$\Sigma x^2 = 55$

$\bar{x} = \frac{15}{5} = 3$

$\bar{y} = \frac{13400}{5} = 2680$

$\bar{x} = \frac{15}{5} = 3$, $\bar{y} = \frac{13400}{}$

Date

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

$$b = \frac{5(42600) - (15)(13400)}{5(55) - (15)^2} = \underline{\underline{240}}$$

$$a = \bar{y} - b\bar{x}$$
$$= 2680 - 240(3)$$
$$\underline{\underline{a = 1960}}$$

$$y = 1960 + 240x \qquad (y = a + bx)$$

$\therefore$ F_{2018} $y = 1960 + 240(6)$ ↳ +2018 ⇒ 5+1=6

$= \underline{₹3400}$ (crores)

Q2) Given the details of sales of a company for a year 2018.

2018

Months	sales ('000s)
Jan	180
Feb	210
Mar	200
Apr	160
May	240
Jun	240
Jul	210
Aug	260
~~Sept~~	
~~Oct~~	
~~Nov~~	
~~Dec~~	

Date

What is sales for the month - September using:

a) 1) Naive method
2) Simple average method
3) 3-months moving method
4) Exponential smoothing method if $\alpha = 0.4$
5) Simple linear regression

1) $F_{sept} = 260$

2) $F_{n+1} = \frac{1}{n}\sum_{t=1}^{n} A_t = \frac{180 + 210 + 200 + 160 + 240 + 240 + 210 + 2\ldots}{8}$

$= \underline{\underline{212.5}}$

3)

		Actual	Forecast
Jan	–	~~Actual~~ 180	~~Forecast~~ –
Feb	–	210	–
Mar	–	200	–
Apr	196.66	160	196.66
May	202.22	140	190
Jun	199.62	240	166.66
Jul	199.51	210	180
Aug	200.45	260	~~59~~ 196.66
Sept	199.86		236.66

4) Month | A_t | F_n if $\alpha = 0.4$

Month	A_t	F_n if $\alpha = 0.4$
Jan	180	
Feb	210	180
Mar	200	192
Apr	160	195.2
May	240	~~213.12~~ 181.12
Jun	240	~~223.872~~ 204.67
Jul	210	~~218.32~~ 206.802
Aug	260	208.08
Sept		~~228.848~~

$F_n = \alpha A_n + (1-\alpha) F_n$

$F_{Mar} = (0.4)(210) + (0.6)(180) = 192$

$F_{Apr} = (0.4)(200) + (0.6)(192) = 195.2$

$F_{May} = (0.4)(\cancel{240}\ 168) + (0.6)(195.2) = \cancel{213.12}\ 181.12$

$F_{Jun} = (0.4)(240) + (0.6)(\cancel{213.12}\ 181.12) = \cancel{223.872}\ 204.67$

$F_{Jul} = (0.4)(210) + (0.6)(\cancel{223.872}) = \cancel{218.32}\ 218.802$

$F_{Aug} = (0.4)(2160) + (0.6)(\cancel{218.32}\ 206.802) = \cancel{234.992}\ 248.08$

$F_{Sept} = (0.4)(260) + (0.6)(208.08) = 233.868$

$F_{Mar} = (0.4)(180) + (0.6)(180) =$

5)

Month	x	y	xy	x^2
Jan	1	180	180	1
Feb	2	210	420	4
Mar	3	200	600	9
Apr	4	160	640	16
May	5	240	1200	25
Jun	6	240	1440	36
Jul	7	210	1440	49
Aug	8	260	2080	64
	$\Sigma x = 36$	$\Sigma y = 1700$	$\Sigma xy = 8030$	$\Sigma x^2 = 204$

Aug Sept

$$b = \frac{n \cdot \Sigma xy - \Sigma x \Sigma y}{n \Sigma x^2 - \Sigma (x)^2} = \frac{8(8030) - 36(1700)}{8(204) - (204)^2}$$

$= ₹ -0.076$

$$a = \bar{y} - b\bar{x} = \frac{1700}{8} + 0.076\left(\frac{36}{8}\right)$$

$= 212.842$

$y = a + bx$

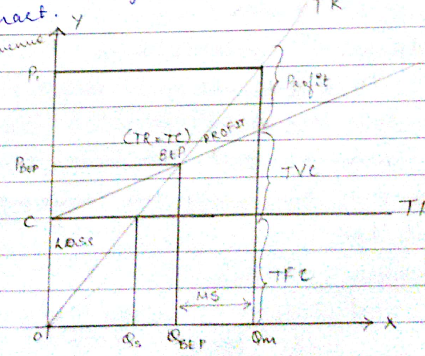
$F_{sept} = 212.842 - 0.076(9)$

$= ₹ 212.158$

Break Even Point

5) Define break even point. Explain with a break-even chart.

A



Algebraic Derivation of BEP

SP - selling price/unit
Q_B - Breakeven ... (faint)

At BEP,

$TR = TC$

where,

$TR = Q_B \times SP$

$TC = TFC + (Q_B \times AVC)$

if $TR = TC$

then, $Q_B \times SP = TFC + (Q_B \times AVC)$

$$\therefore \boxed{Q_B = \frac{TFC}{SP - VC}}$$

$$\text{or } \boxed{BEP = \frac{TFC}{SP - VC}}$$

Q1) Given,

TFC = ₹ 2,10,000

SP/unit = ₹ 10

VC/unit = ₹ 7

Compute the units the amounts of sales at BEP

$BEP = \frac{TFC}{SP - VC} = \frac{₹ 210000}{₹10 - ₹7} = 70,000$ units (volume)

[SP - VC also called as **Contribution Margin**]

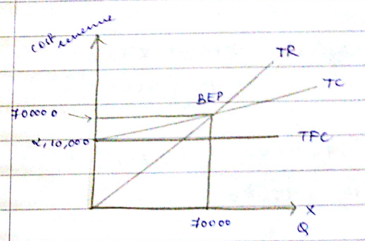
SP = AFC + AVC + Profit

(SP - VC) = FC + Profit

~~Sales value ₹10~~

Then, ₹

BEP Sales value = (₹10 × 70000) = **₹700000**



Q2) A firm can manufacture a maximum of 10,000 units per month. The estimated variable cost per unit and selling price per unit are ₹100 and ₹850 respectively. TFC = ₹700000

(a) What is BEP sales volume and value?

(b) Estimate the BEP percentage of plant capacity.

(a) $BEP = \frac{TFC}{SP - VC} = \frac{700000}{850 - 100} = 933.333$ units

$\therefore$ BEP Sales value = 933.33 × ₹850 = ₹793333.3333

Date

Average contribution margin

(b) % BEP plant capacity = ACM × Total plant capacity

$= 933.333 \times ₹750$

SP-VC = 850-100

$= \cancel{6.9} = ₹699999.75$

$\% BEP = \frac{TFC}{(SP-VC) \times TPCapacity} \times 100$

Total plant capacity = ₹10000 × ₹750
= 75 00000

$$\left[= \frac{700000}{100 \times 7500000} \times 100 \right]$$

$\frac{BEP\ value}{Max\ units} \times 100 = \frac{933.33}{\underset{Quantity}{10000}} \times 100 = \underline{9.33\%}$

Q3) Given

FC = ₹1,00,000

VC/unit = ₹30

SP/unit = ₹40

Calculate:

1) BEP units

2) SP per unit if BEP is brought down to 8000 units

#

#

Date

1) $BEP = \frac{TFC}{(SP-VC)} = \frac{₹100000}{₹40 - ₹30} = \underline{10000\ units}$

2) $8000 = \frac{₹100000}{x - ₹30}$

$8000x - ₹30(8000) = 100000$

$8000x - 240000 = 100000$

$x = \underline{42.5}$

Q4) Compute the BEP, if

Sales — ₹100,000

TVC — ₹60,000

TFC — ₹30,000

Here SP & VC are not per unit so,

$BEP = \frac{TFC}{1 - VC/Sales}$ } if values are given in one sum

$= \frac{20,000}{1 - 60,000/100000} = ₹5,000$

#

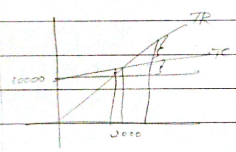
#

Q5) A manufacture of product X buys a certain component at ~~(rupee)~~ ₹80 each. In case he makes it himself the fixed cost and variable cost would be ₹10,000 and ₹3 /component respectively. Should the manufacturer make or buy the component

→ $$BEP = \frac{TFC}{(SP-VC)} = \frac{₹10000}{₹8 - ₹3} = \underline{\underline{2000 \text{ units}}}$$

~~(SP-VC)~~ →

Rough Work



If the units required is greater than 2000 units it is feasible to make rather than buy. Otherwise, it is better to buy.

Q6) If the fixed cost of a company is ₹60000, the variable cost and selling price per unit are ₹10 and ₹20 respectively, find BEP. If the company sells 10000 units of the product find the margin of safety (safety margin). ~~in terms~~ of the company in terms of units and sales value.

$$BEP = \frac{TFC}{(SP-VC)} = \frac{₹60000}{₹20 - ₹10} = \underline{\underline{6000 \text{ units}}}$$

$MS = \text{Sales} - \text{BEP sales}$

$$\% MS = \frac{\text{Sales} - \text{BEP sales}}{\text{Sales}} \times 100\%$$

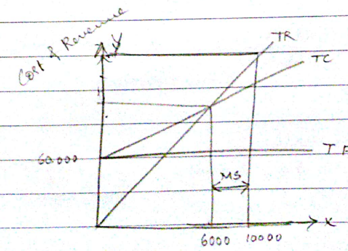
Other formulas,

$$MS = \frac{\text{Profit}}{P/V \text{ ratio}}$$

where,

$$P/V \text{ ratio} = \frac{\text{Profit}}{\left[\frac{SP - VC}{\text{Sales}} \times 100\right]}$$

$MS = \text{Sales} - \text{BEP Sales} = 10000 - 6000 = \underline{\underline{4000 \text{ units}}}$



$MS_{\text{value}} = [10000 \times 20] - [6000 \times 20]$

$= \underline{\underline{80000}}$ units

What makes you happy?
#HappyCollegeDays
#
#

Q 7) Calculate the BEP and sales value at this point (BEP) from the following data :

(a) BEP

(b) Direct material cost - ₹8/unit - VC

Direct labour cost - ₹5/unit - VC

Fixed overheads - ₹24,000 - FC

variable overheads - @ 60% on direct labour - VC

Selling Price - ₹25 per unit

Trade discount - 4% → always on SP

(b) If the sales is 20% above BEP, determine the net profit.

→ (a) TFC = ₹24,000

$\frac{60}{100} \times 5$

VC = ₹8 + ₹5 + ₹3 = ₹16

SP = ₹25 − $\left(25 \times \frac{4}{100}\right)$ = ₹24

BEP = $\frac{TFC}{SP - VC}$ = $\frac{₹24000}{₹24 - ₹16}$ = $\underline{3000 \text{ units}}$

and BEP sales value

= ₹24 × 3000 = $\underline{₹72{,}000}$

(b) 3000 + $\left(\frac{3000 \times 20}{100}\right)$ = $\underline{3600 \text{ units}}$

∴ Profit = TR − TC = [3600 × ₹24] − [₹24000 + (₹3600 × ₹16)]

= $\underline{₹4800}$

What makes you happy?

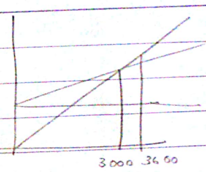
OR

TR = SP × Q

TC = TFC + TVC

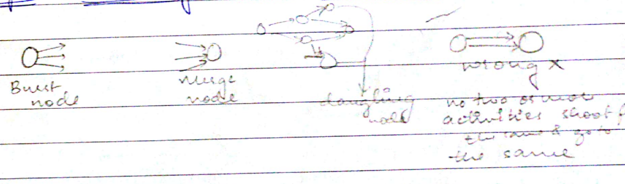
= TFC + [AVC × Q]

∴ Profit = TR − TC



Unit-V

Project Planning and Aquisition



Crossing arrows wrong

Q1) Given the details of a project :

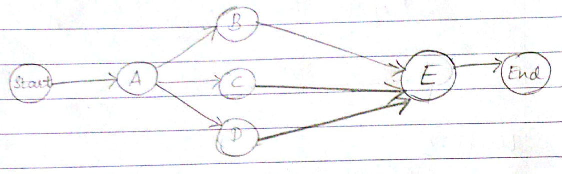
Task	Follows Task(s) → immediate predecessor
A	–
B	A
C	A
D	A
E	B, C, D

Draw:

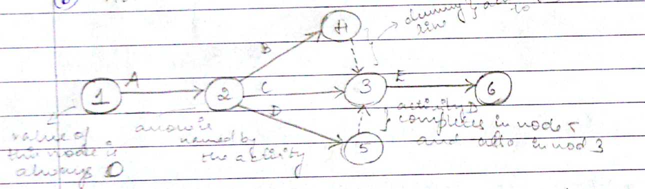
(a) circle (AON) network diagram

(b) Arrow Network diagram

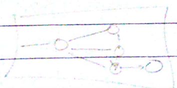
(a)



(b) AND → nodes are ~~not~~ numbers



You can use as many dummy as needed
Use has less dummy as possible



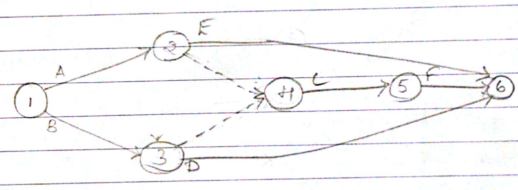
X not possible

Q2)

Task	Follows Task(s)
A	–
B	–
C	AB
D	B
E	A
F	C

Those which are not predecessor to any other are for Last node

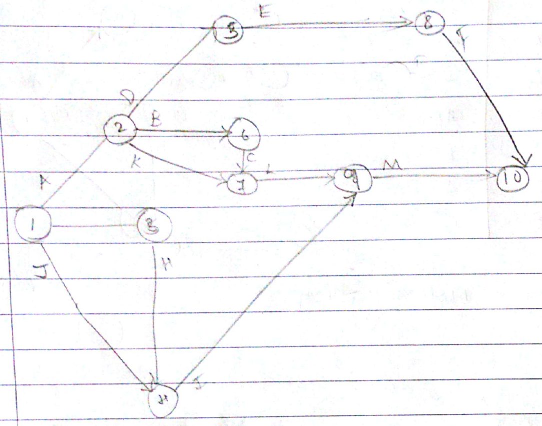
Arrow Network Diagram



Q3)

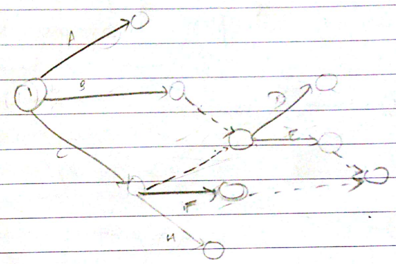
Task	Immediate Predecessors
A	–
B	A
C	B
D	A
E	D
F	E
G	–
H	G
I	H, J
J	–
K	A
L	C, K
M	I, ~~L~~

What makes you happy?
#HappyCollegeDays



Q4)

Task	Immediate Predicessor
A	–
B	–
C	–
D	B, C
E	B, C
F	C
G	D, J
H	C
J	E, F
K	E, F
M	A, H, K



Critical Path Method (CPM)

Q7) Given: the details of a project

Task	Follows Task(s)	Duration (weeks)	Manning level
A	–	0.6	3
B	–	0.5	4
C	–	0.5	3
D	A	0.3	2
E	A, B	0.6	5
F	D, E, C	0.1	2

man power reqs or no. of employees

(a) Draw a circle (AON) network diagram

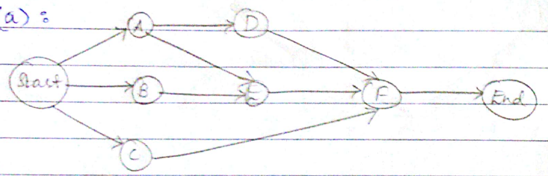
(b) Draw an arrow network diagram → CPM network diagram

(c) Identify the critical path activities and length of critical paths

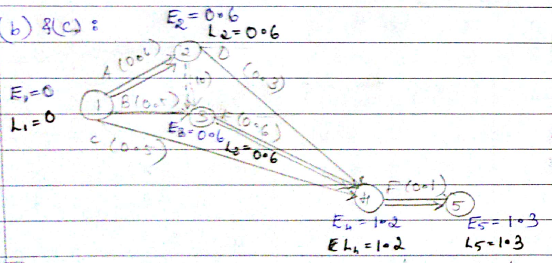
Date

(d) Identify the length of critical path using GANTT (Bar) chart, and estimate the optimum planning level of power requirement to complete the project

→ (a) :



(b) & (c) :



[Moving from start to end → forward pass
End to start → backward pass]

$i \xrightarrow{A(8)} j$ ij → task

D_{ij} → Duration

earliest time

E_{ij} → How early you can start (i) and how early to you can end (j)

L_{ij} → Latest time

What makes you happy?
#HappyCollegeDays

#
#

★ $\boxed{E_{ij} \rightarrow \text{Arrows shooting into the node} \rightarrow \text{(Consider) (Maximum value)}}$

$E_{ij} = L_{ij}$
forward   backward

$E_2 \rightarrow$ make additions $\rightarrow 0 + 0.6$

for $E_3 \rightarrow$ ~~from~~ 1 and 2 shooting in

1 → 0 + 0.5
5 → 0.6 } Max = 0.6

$E_4 \rightarrow \underset{E_2}{0.6} + 0.3 = 0.9$

$\underset{E_3}{0.6} + 0.6 = 1.2$

$\underset{E_1}{0} + 0.5 = 0.5$

$E_5 \rightarrow 1.2 + 0.1$

$\boxed{L_{ij} = \text{Arrows shooting out the node} - \text{Minimum value}}$

$L_2 = 1.2 - 0.3 = 0.9$ $L_1 = 0.6 - 0.6 = 0$

~~$1.2 - 0.6 = 0.6$~~ $0.6 - 0.5 = 0.1$

$0.6 - 0 = 0.6$ $1.2 - 0.5 = 0.7$

Now identify critical path ~~in~~ with double line, with equality condition (from where you got the values)

Critical path : 1 → 2 - - → 3 → 4 → 5

Critical path tasks : A → dummy → E → F

Length of path : 0.6 + 0 + 0.6 + 0.1 = 1.3

consider duration values

What makes you happy?
#HappyCollegeDays

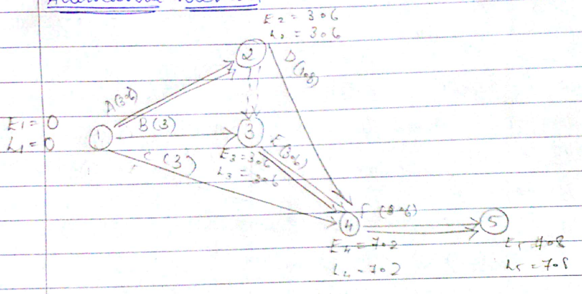
#
#

employement × 6 → 6 working days

costs × 7

Date

Alternative method



$0.6 \times 36 = 3.6$

↳ working days (duration × working days)

For GANTT chart you need to have ~~ea~~ either weeks, months, days or years, hence follow this method.

Critical path : ① → ② - - → ③ → ④ → ⑤

Critical path tasks A → dummy → E → F

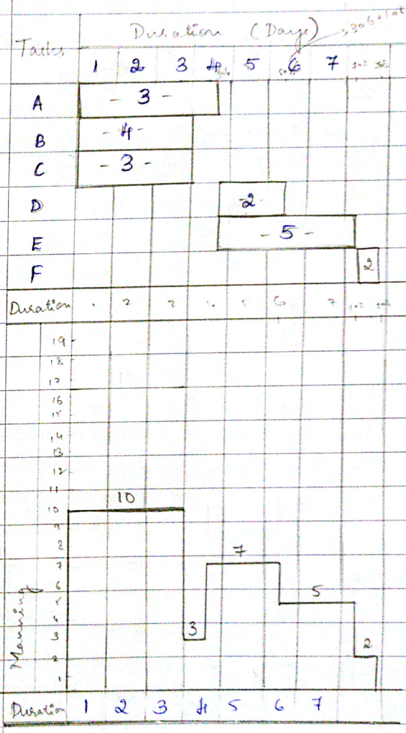
~~Crit~~ Length critical path : ~~36~~ 3.6 + 0 + 3.6 + 0.6 = 7.8 days

17 because maximum total

Date

GANTT Chart

(Scaling important)



First till week 3
3 + 4 + 3 = 10

Optimum no. of employee (man power) required is 10.

Note:

Suppose explicitly given Jan 1st 2019 then my Table would be,

Task Year 2019

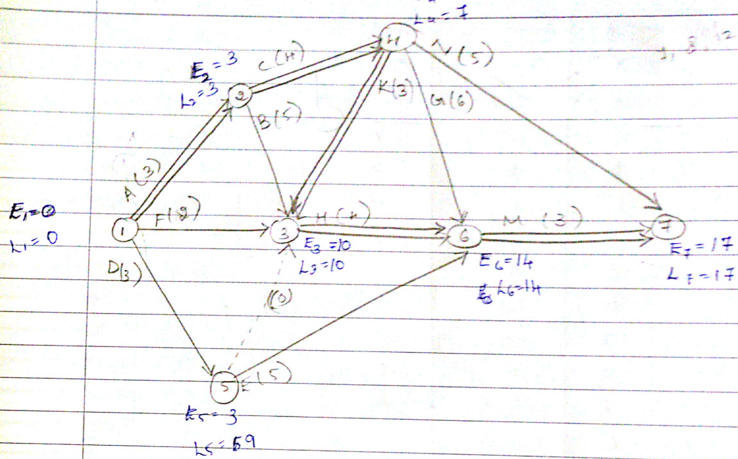
Month Jan

Dates 1 2 3 4 5 6 7 -- -- 31

if this is a Sunday shade

Q2) Task	Follows Task (s)	Duration (Days)
A	—	3
B	A	5
C	A	4
D	—	3
E	D	5
F	—	2
G	C	6
H	~~B~~ B, D, F, K	4
K	C	3
M	G, ~~B~~ H, E	3
N	C	5

Arrow Network Diagram, critical path. length



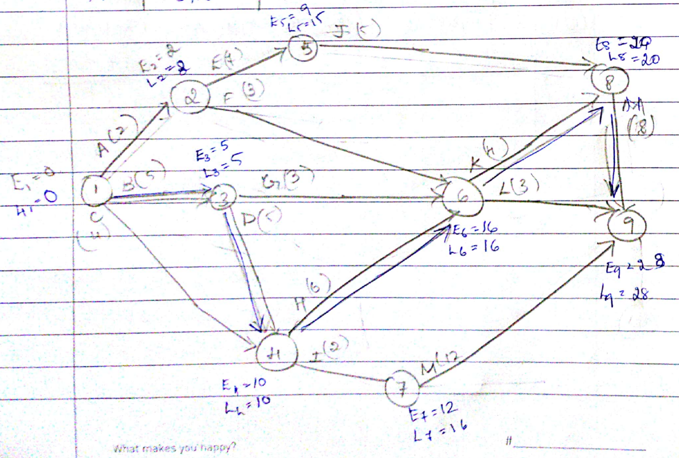
Critical path: 1 → 2 → 4 → 3 → 6 → 7

Critical path tasks (activities): (~~A → C → N~~) A → C → K → H → M

Length critical path: 3 + 4 + 3 + 4 + 3 = 17 days

Q3)

Task	Follows Tasks(s)	Duration (Days)
A	–	2
B	–	5
C	–	4
D	B	5
E	A	7
F	A	3
G	B	3
H	C, D	6
I	C, D	2
J	E	5
K	F, G, H	4
L	F, G, H	3
M	I	12
N	J, K	8



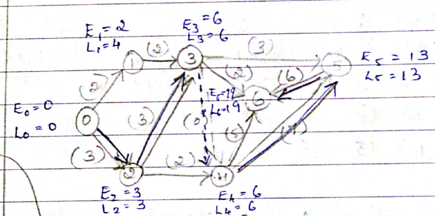
Critical path : ① → ③ → ④ → ⑥ → ⑧ → ⑨

Critical path activities : B → D → H → K → N

Length critical path : 5 + 5 + 6 + 4 + 8 = 28 days

Q4) Given the detail of a project

i j	D_{ij} (weeks)
0-1	2
0-2	3
1-3	2
2-3	3
2-4	2
3-4	0
3-5	3
3-6	2
4-5	7
4-6	5
5-6	6



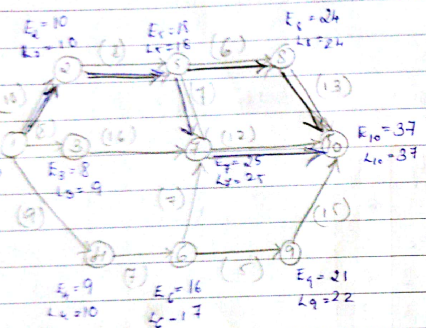
Zero activity is a dummy activity

CP : 0 → 2 → 3 - - - → 4 → 5 → 6

~~CPA :~~

LCP : 3 + 3 + 0 + 7 + 6 = 19 ~~days~~ weeks

ij	D_{ij} (days)
(1,2)	10
(1,3)	8
(1,4)	9
(2,5)	8
(4,6)	7
(3,7)	16
(5,7)	7
(6,7)	7
(5,8)	6
(6,9)	5
(7,10)	12
(8,10)	13
(9,10)	15



2 critical paths (mention both seperately)

1) 1 → 2 → 5 → 7 → 10
   1 → 2 → 5 → 8 → 10

Length = 37

Project Evaluation and Review Technology [PERT]

Equations:

$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

where,

t_e - expected time to complete an activity (task)

t_o - optimise time to complete an activity

t_m - mostly likely time to complete an activity

t_p - pessimistic time to complete an activity

$$\sigma = \frac{t_p - t_o}{6} \quad ; \text{ and } \quad \sigma^2 = \left[\frac{t_p - t_o}{6}\right]^2$$

T_e = Expected project completion time [critical path length]

$$\sigma_T = \sqrt{\Sigma\sigma^2 \text{ of critical path activities}}$$

The probability of completing the project by scheduled time (T_s)

$$\text{Prob}\left(z \le \frac{T_s - T_e}{\sigma_T}\right)$$

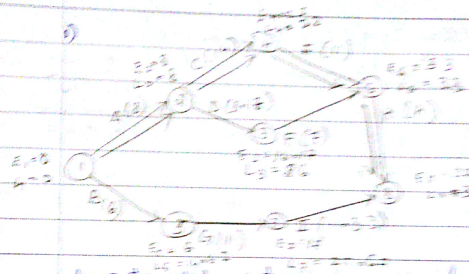
81) Given the details of a project:

Activity	Follows Activity	t_o	t_m	t_p	t_e	σ	σ^2
A	–	4	4	16	8	2	4
B	–	1	5	15	6	2.33	5.42
C	A	6	12	30	14	4	16
D	A	2	8	15	8.17	2.166	4.691
E	C	5	11	17	11	2	4
F	D	3	6	15	7	2	4
G	B	3	9	27	11	4	16
H	E, F	1	4	7	4	1	1
I	G	4	9	28	11.33	4	16

Time (weeks)

1) Draw a PERT network diagram
2) Identify the critical path and expected project completion time and also std deviation.
3) Find the probability that the project is completed in 36 weeks.
4) If the project manager wishes to be 99% sure that the project is completed, what must be the scheduled time of the project.

1)



$$t_e = \frac{t_o + 4t_m + t_p}{6} \qquad \sigma = \frac{t_p - t_o}{6}$$

2) CP = ① – ③ – ⑤ – ⑥ – ⑦

CPA = A → C → E → H

∴ T_E = 8 + 14 + 11 + 4 = 37 weeks

$$\sigma^2 = \left[\frac{t_p - t_o}{6}\right]^2$$

$$\sigma_T = \sqrt{\Sigma\sigma^2 \text{ critical activities}}$$

only Σ of critical activities only

$$= \sqrt{4 + 16 + 4 + 1}$$

$\sigma_T = 5$

3) $$z = \frac{T_S - T_E}{\sigma_T} = \frac{36 - 37}{5} = \frac{-1}{5} = -0.2$$

z = −0.2 ; probability is 0.4207 ≈ 42.07%

4) if probability is at 99% $\simeq$ 0.9900
(ulta of the previous)
(table ka right side dek)

then = 2.33

$\therefore 2.33 = \dfrac{T_s - T_e}{\sigma_T}$

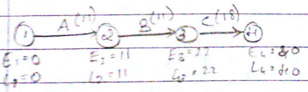
$2.33 = \dfrac{T_s - 37}{5}$

$\therefore T_s = 48.65$ weeks

Q2) The following activities of a project are completed in a series

Tasks	Time (Days) to	tm	tp	te	σ	σ^2
A	8	11	14	11	1	1
B	7	10	19	11	2	4
C	10	19	22	18	2	4

Calculate : (a) te (c) Te and σ_T
(b) σ (d) Probability of completing the project in (i) 40 days
(ii) 46 days



a) CP = 1 → 2 → 3 → 4
~~CPA~~ = CLP = ~~40 weeks~~ day = Te

$\sigma_T = \sqrt{1+4+4} = \underline{3}$

b) $Z = \dfrac{T_s - T_e}{\sigma_T}$

(i) $Z = \dfrac{40 - 40}{3} = 0$

c) Probability is 0.5000 $\simeq$ 50%

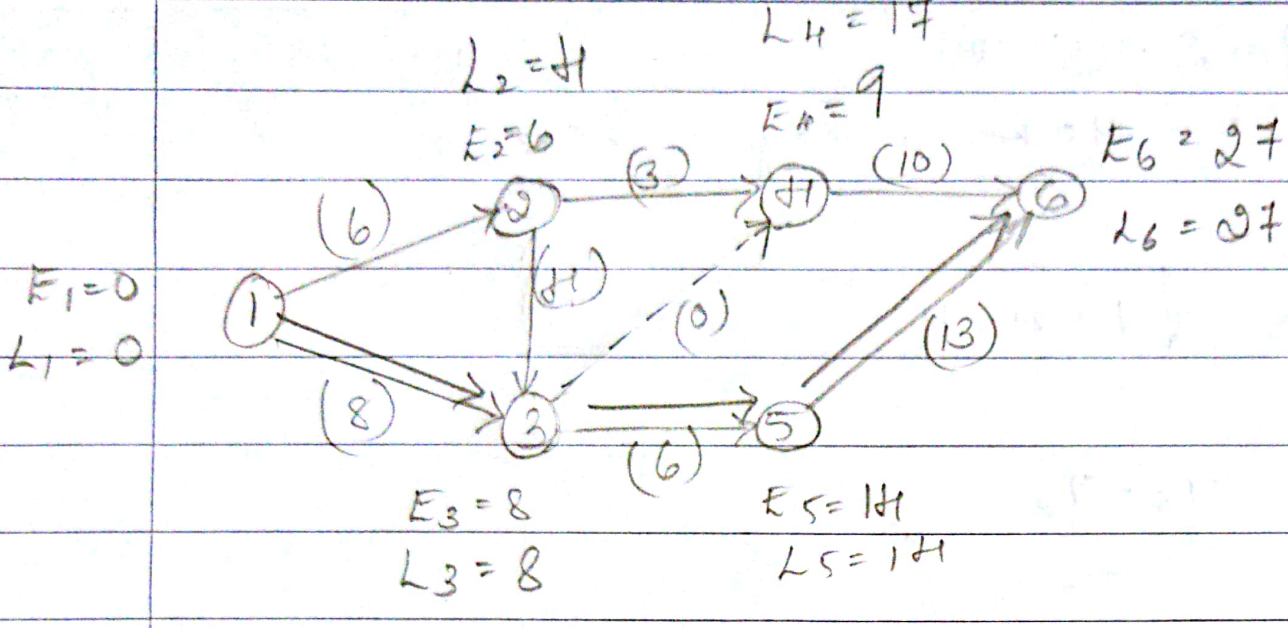
(ii) $\dfrac{46 - 40}{3} = \dfrac{6}{3} = 2$

d) probability is 0.9773 $\simeq$ 97.73%

Q3)

Tasks	Time (Days) to	tm	tp	te	σ	σ^2
1-2	2	6	10	6	1.33	1.7689
1-3	4	8	12	8	1.33	1.7689
2-3	2	4	6	4	0.667	0.44
2-4	2	3	4	3	0.33	0.1089
3-4	0	0	0	0	0	0
3-5	3	6	9	6	1	1
4-6	6	10	14	10	1.33	1.7689
5-6	1	3	5	3	0.667	0.44

what is the probability of completing the project in 22 days?



CP = 1 → 3 → 5 → 6

LCP = 27

$$\sigma_T = \sqrt{1.7689 + 1 + 0.44}$$

$$\sigma_T = 1.7913$$

$$z = \frac{T_s - T_e}{\sigma_T} = \frac{22 - 27}{1.7913} = -2.79$$

$= 0.0192 \quad = 1.92$

$= 2\%$