Bashundhara
Exercise Book
Write Your Future

Sadman
IPE (A)
011221592

W 23.1.24

IPE

Councilling room → 619

Engineering Economy

→ The value of money.

P → present value

F → Future value

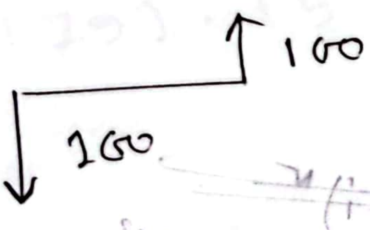
N → Number of interest periods

i% → interest rate

$$P = \frac{F}{(1+i)^N}, \quad F = P(1+i)^N$$

(-) cash flow | cash out flow

(+) cash flow | cash in flow



P.T.O

* Annuity → যে টাকা চলে যায় (-)

asset → ~~যে~~ টাকা আসবে (+)

Find the annuity 5%এ

0	1	2	3
	-100	-100	-100
	F_1	F_2	F_3

$$P = P_1 + P_2 + P_3$$

$$= \frac{F_1}{(1+i)^N} + \frac{F_2}{(1+i)^N} + \frac{F_3}{(1+i)^N}$$

$$= \frac{-100}{\left(1+\frac{5}{100}\right)^1} + \frac{-100}{\left(1+\frac{5}{100}\right)^2} + \frac{-100}{\left(1+\frac{5}{100}\right)^3}$$

$$= -272.32 \ \$$$

$$\cancel{F = F_1 + F_2 + F_3 = P(1+i)^N}$$

$$\cancel{= 272.32\left(1+\frac{5}{100}\right)^{N=3}}$$

$$\cancel{= 285.936} = 316.24$$

C.W 27.7.22

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* 5th year 12% interest rate.

0	1	2	3	4	5
\$0	\$100	\$300	\$300	\$300	\$500
	P_1				P_5
		F_2			F_5

12%

$$F = F_1 + F_2 + F_3 + F_4 + F_5$$

$$= P_1(1+i)^{N_1} + P_2(1+i)^{N_2} + P_3(1+i)^{N_3} + P_4(1+i)^{N_4} + P_5(1+i)^{N_5}$$

$$= 100\left(1+\frac{12}{100}\right)^4 + 300\left(1+\frac{12}{100}\right)^3 + 300\left(1+\frac{12}{100}\right)^2 + 300\left(1+\frac{12}{100}\right)^1 + 500\left(1+\frac{12}{100}\right)^0$$

$$= 1791.15\ \$$$

* compounded Annually 10%

* compounded semi anually 10%

$$\boxed{\begin{array}{l}\text{Effective annual rate} \\ (EFF\%) = \left(1 + \frac{I_{Nom}}{M}\right)^{M} - 1\end{array}}$$

~~E_5~~

~~compounded annually~~

$$\cancel{= \left(1 + \frac{100}{3}\right)^{3} - 1}$$

3

Eg

$F_1 = P(1+i)^N$

$= 100\left(1+\frac{8}{100}\right)^3$ [3rd year]

$= 125.9712$ \$

$EFF = \left(1+\frac{0.08}{12}\right)^{12} - 1$

$= 0.08299 = 8.299\%$ [monthly]

$\therefore F_2 = 100(1+0.08299)^3$

$= 127.0203$ \$ Ans

Ameek invested some money compounded quatерly 12% for 43 years and got 5 million when Ameek got his first million?

~~F = 5 million~~

~~N = 43~~

$$\cancel{EFF = \left(1 + \frac{0.12}{4}\right)^4 - 1}$$

$$\cancel{= 0.1255}$$

$$\cancel{\therefore P = \frac{F}{(1+i)^N}}$$

$$\cancel{= \frac{5}{(1+0.1255)^{43}}}$$

$= 0.031$ million.

~~0.037 → 1~~

~~1 → 0.037~~

0.037 → 1

1 → 0.037

32.25

$F = 5000000\ \$$

$EFF = \left(1 + \frac{0.12}{4}\right)^4 - 1$

$= 0.1255 =$

$$P = \frac{5000000}{(1 + 0.1255)^{43}} = \$30982.2913$$

$$F = P(1+i)^N$$

$$\Rightarrow \frac{1000000}{30982.29} = (1+0.1255)^N$$

$$\Rightarrow 32.2765 = (1.1255)^N$$

$$\Rightarrow \ln(32.2765) = \ln(1.1255)^N$$

$$\Rightarrow 3.4743 = N \; 0.11823$$

$$\Rightarrow N = 29.386 \text{ year}$$

E-6

F = $100

i = 8%

N = 3

$$P = \frac{F}{(1+i)^N} = \frac{100}{\left(1+\frac{8}{100}\right)^3}$$

= 79.3832 $

$$E_{ff} = \left(1 + \frac{I_{NOM}}{M}\right)^M - 1$$

$$= \left(1 + \frac{0.08}{12}\right)^{12} - 1$$

= 0.0829995

$$\therefore P = \frac{100}{(1+0.082999)^3}$$

= 78.7256 $

Ans

CW 30.1.24 Chapter-2 IPE

* Manager, organization, management

→ Organization
- → people
- → goal
- → systematic structure

→ Management
- → people, resource
- → effectively & efficient
- → Doing the right thing
- → Doing ~~the~~ things right

P.T.O

four functions of management

→ planning

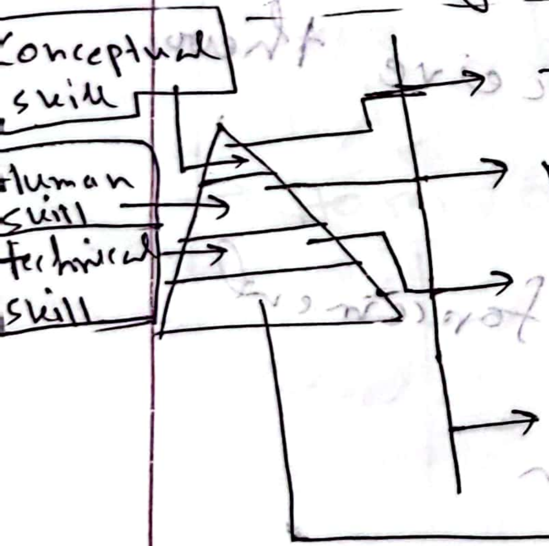
→ Organizing

→ Leading

→ controlling.

Types of manager:

(1) management level:-



→ top managers (GM, CEO, DMD)

→ Middle Managers (M, SM, AGM, DGM)

→ first-line managers (MT, TMT, AM, PM)

→ Nonmanagerial employees (Technician, Fitter, Janitor)

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(ii) ~~Functional~~

(*) Functional:

→ ~~producting~~ production
→ marketing
→ finance

(*) General

→ President
→ CEO

(iii) How manager perceive their employees:

→ X → negative reinforcement
→ Y → positive

P.T.O

6-Feb C.T

Chapter 2 & 3

* Stratagy → plan
  execution

* Plan → think

Corporate stratagy:

→ Growth stratagies:

- → Concentration
- → Vertical integration
  - → Backward
  - → forward
- → Horizontal Integration
  - → Acquisition
  - → Merging:
- → Diversification

3.2.24

IPE

* Stability

* Renewal Strategy

* BCG Matrix

(+) growth rate ↕ / (+) Market share ↔		
	Stars	Question marks
	Cash cows	Dogs

Challenges of management →

→ The need for vision → (Nokia)

→ The need for ethics → (Volkswagen)

→ The need for responsiveness to cultural diversity. (Walmart)

P.T.O.

Chapter-4

Project selection

Project

S → specific

M → Measurable

A → Achievable

R → Realistic

T → Time oriented

(I) NPV

(II) IRR

(III) Pay back period

(IV) Benefit cost analysis

Project S

0	1	2	3	4	5
-1000	500	200	100	80	350

14%

Project L

0	1	2	3	4	5
-1000	800	50	250	350	100

for profit NPV > 0

[selection criteria]

(5) NPV

$$= -1000 + \frac{500}{(1+0.14)^1} + \frac{200}{(1+0.14)^2} + \frac{100}{(1+0.14)^3} + \frac{80}{(1+0.14)^4} + \frac{350}{(1+0.14)^5}$$

$= -110.87\ \$ < 0$ [not selected]

(2) NPV

$$= -1000 + \frac{800}{1.14} + \frac{50}{(1.14)^2} + \frac{250}{(1.14)^3} + \frac{350}{(1.14)^4} + \frac{100}{(1.14)^5}$$

$= 168.24\ \$ > 0$

6.2.24

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IRR

Internal Rate of Return

NPV = 0

5

0	1	2	3	4	5
-1000	800	600	62	30	253

15% WACC

(14% ≈ x)

$\Rightarrow 0 = P_0 + P_1 + P_2 + P_3 + P_4 + P_5$

$\Rightarrow 0 = -1000 + \frac{800}{x} + \frac{600}{x^2} + \frac{62}{x^3} + \frac{30}{x^4} + \frac{253}{x^5}$

$\Rightarrow -1000x^5 + 800x^4 + 600x^3 + 62x^2 + 30x + 253 = 0 \quad \ldots (1)$

[Trial & Error]

WACC → Weighted Average cost of capital

Calculator

$x = 1.15$, R.H.S $= 668.55$

$x = 1.25$, R.H.S $= 459.05$

$x = 1.35$, R.H.S $= 54.07$

$x = 1.36$, R.H.S $= 0.128 \approx 0$

($\pm$ 1.5) [0 limit]

MARR $\rightarrow$ Minimum attractive rate of return;

C.W 10.2.24

IPF

0	1	2	3	4	5
-1000	400	450	600	211	250

$\Rightarrow -1000x^5 + 400x^4 + 450x^3 + 600x^2 + 211x + 250 = 0$ ---

$x = 1.15$, R.H.S $= 658.789$

$x = 1.25$, R.H.S $= 254.96$

$x = 1.30$ " $= -43.54$

$x = 1.29$ " $= 22.046$

$x = 0.01$ $\quad$ 65.59 [Interpolation]

Diff between R.H.S 65.59 [bet x]

" " " 43.54

0.01

65.59

$\frac{0.01 \times 43.54}{65.59}$

$= 6.638 \times 10^{-3}$

$= 0.0066$

$x = 1.30 - 0.0066$

$= 1.2934$ R.H.S = 0.09

Or

$$\frac{0.01 \times 22.05}{65.59} = 0.0034$$

$(1.29 + 0.0034) \rightarrow 1.2934$

15%	0	1	2	3	4	5
cash flow	-1000	400	450	600	211	250
Discounted cash flow	-1000	347.83	340.26	394.51	120.64	124.29

[Pay back period]

(i) conventional payback

(ii) discounted payback

Discounted cash flow payback

$P_0 = -1000$

$P_1 = \frac{400}{(1+0.15)^1} = 347.83$

$P_2 = \frac{450}{(1.15)^2} = 340.26$

$P_3 = 394.51$

$P_4 = 120.64$

$P_5 = 124.29$

Cumulative

Dis Cash flow

-1000	-652.17	-311.91	82.6	203.25
				327.53

Payback period

$= \text{Num of years before full recovery} + \dfrac{\text{last unrecovered cost}}{\text{Cash flow during full recovery}}$

$= 2 + \dfrac{321.91}{394.51}$

$= 2.79$ years

15%	0	1	2	3	4	5
	-1000	800	600	61	30	253
	-1000	695.65	453.69	40.11	17.15	125.79
	-1000	-304.35	149.34	189.[illegible]45	206.6	332.5

$\therefore$ PBP

$= 1 + \frac{304.35}{453.69}$

$= 1.67$ year.

benifit cost ratio

12.)

	0	1	2	3	4	5
(+) Benifit			600	61	30	253
(−) cost	200	200	15	100	50	25

$P_{Benifit} = \frac{600}{1.12^2} + \frac{61}{1.12^3} + \frac{30}{1.12^4} + \frac{253}{1.12^5}$

$= 684.36\$$

$P_{cost} = 501.99\$$

Chapter 2, 3, 4 ∫

$$\frac{B}{C} = \frac{684.36}{501.99}$$

$= 1.36 > 1$

Benefit is greater than cost.

GW 12.2.24

* Marketing & marketing management

→ set of processes for creating, communicating and delivering values.

P.T.O.

What is marketed?
→ Goods (tangible)
→ Services (intangible)
→ persons.
→ Events
→ Experiences.

* Marketing mix (4P)
→ Product, Price, promotion, Place.

* Micro-marketing has 4 levels.

→ Segment marketing
→ Niche marketing
→ local marketing
→ Individual marketing

* Brand & Brand equity.

C.W
13. 2. 24

Choosing Brand Elements

→ Memorable
→ Meaningful
→ likable
→ Transferable
→ Adaptable
→ Protectable

"Victorious mule" → concept 1980-

Color emotion guide

→ optimism
→ friendly
→ Excitement
→ creative
→ Trust
→

C.T-2 (Feb 27) Tuesday
(Chapter 4 & 5)

Interesting marketing strategies
→ Guerilla marketing.
→ Ambush marketing

C.W 17.2.24

IPE

* Gray market
* Black Market

6

(i) Raw Material inventory
(ii) work in progress inventory
(iii) MRO (Maintainance Repair operation)
(iv) Finished good. inventory.

ABC analysis
A → High Annual dollar volume → 70%
B → Intermediate " " → 20%
C → low " " → 10%

Item No	Annual Volume	per unit cost	Annual Dollar Volume	% of annual dollar volume
1	500	5	2500	1.03
2	5000	2	10000	4.12
3	50	45	2250	0.93
4	47	1500	70500	29.07
5	872	120	104520	43.10
6	256	50	12800	5.28
7	5000	0.5	2500	1.03
8	10,000	0.4	4000	1.65
9	15,000	1	15,000	6.19
10	100	1.5	150	0.06
11	70	30	2100	0.87
12	800	0.2	160	0.07
13	1600	10	16000	6.60
			242480	

$\frac{2500 \times 100}{242480}$

organized by Decending order

Item No:	%		Class
5	43.10	72.17	A
4	29.07		
13	6.60		
9	6.29	22.19	B
6	5.28		
2	4.22		
8	1.65		
1	1.03		
7	1.93	5.64	C
3	0.93		
11	0.87		
12	0.07		
10	0.06		

C.W 27.2.24

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Holding per unit per year

* EOQ (economic order quantity)

* POQ (Production " ")

C.W 2.3.24

S ordering cost per order

Annual amount D

Order Quantity Q

H holding cost per unit per year

Annual ordering cost = Annual holding cost//

$$\Rightarrow \left(\frac{D}{Q}\right) S = \left(\frac{Q}{2}\right) H$$

$$\Rightarrow \frac{2DS}{H} = Q^2$$

$$\Rightarrow Q^* = \sqrt{\frac{2DS}{H}} \quad (EOQ)$$

$$Q^* = \sqrt{\frac{2DS}{H\left(1-\frac{d}{P}\right)}}$$

$d \rightarrow$ daily usage (production rate)

$P \rightarrow$ production

* In a RMG factory Annual demand of needles is 75,000 units. The factory operates for 250 days in a year. cost associated with each order is 100 \$ and holding cost is 2 \$ per unit per year. Each ~~piece~~ piece needle costs 1 \$ to purchase. Lead time for needles are 5 days.

(i) Determine optimal / Economic order quantity.

(ii) Number of orders per year.

(iii) Expected time between orders.

(iv) Total Annual cost

(v) Re order point (ROQ)

(vi) If production rate is 400 units per day, Determine optimal order quantity?

Sol (i) $Q^* = \sqrt{\frac{2DS}{H}}$

$= \sqrt{\frac{2 \times 75,000 \times 100}{2}}$

$= 2738.613$ units

(ii)

$$N = \frac{D}{Q^*} = \frac{75,000}{2738.613}$$

$= 27.39$ orders

(iii)

$$t = \frac{250}{N}$$

$$= \frac{250}{27.39} = 9.13 \text{ days}$$

(iv)

Total ~~ordering~~ cost

= Annual ordering + Annual holding + purchasing cost

= $\left(\frac{D}{Q^*}\right)S + \left(\frac{Q^*}{2}\right)H + PD$

per piece price

= 80477.23 ₹

(V)

$$ROP = \overset{\text{lord time}}{L} \times \text{daily usage}$$

$$= 5 \times \frac{7500 \rightarrow \text{total amount}}{250 \rightarrow \text{year day}}$$

$$= 150$$

(VI)

$$d = \frac{7500}{250} = 300$$

$$Q^* = \sqrt{\frac{2 \times 75{,}000 \times 100}{2\left(1 - \frac{300}{400}\right)}}$$

$$= 5477.23$$

annual demand 5000

ordering cost 49 \$ per order

$M_1 = 5$ \$

$M_2 = 5 - (5 \times 4\%) = 4.8$ \$

$M_3 = 5 - (5 \times 5\%) = 4.75$ \$

$H_1 = 5 \times 20\% = 1$ \$

$H_2 = 4.8 \times 20\% = 0.96$ \$

$H_3 = 4.75 \times 20\% = 0.95$ \$

$Q_1^* = \sqrt{\dfrac{2 \times 5000 \times 49}{1}} = 700$

$Q_2 = 1000$

$Q_2^* = \sqrt{\dfrac{2 \times 5000 \times 49}{0.96}} = 714.43$

[not feasible]

$Q_3^* = 2000$

$Q_3^* = \sqrt{\dfrac{2 \times 5000 \times 49}{0.95}} = 718.18$ [" "]

$$T_{C_1} = \left(\frac{5000}{700}\right) \times 49 + \left(\frac{700}{2}\right) \times 1 + (5 \times 5000)$$

$$= 25700$$

$$T_{C_2} = \left(\frac{5000}{1000}\right) 49 + \left(\frac{1000}{2}\right) \times 0.96 + (4.8 \times 5000)$$

$$= 24725 \text{ [lowest cost]}$$

$$T_{C_3} = \left(\frac{5000}{2000}\right) 49 + \left(\frac{2000}{2}\right) 0.95 + (4.75 \times 5000)$$

$$= 24822.5$$

[not feasible]

I

So, 1000 is the optimal substructure property.

Naive approach

Period	Actual	F
1	150	150 +1
2	152	151 151+1=152
3	154	154 +3
4		154+3 154+2

Trend present

No Trend Present last period value = Next Period forecasting

Moving Average

3 Period moving Average of year 2007

$MA_{2007} = \frac{75+85+90}{3} = \frac{250}{3} = 83.37$

Period		Actual	weight forecasting
2007	1	40	.10
	2	60	.20
	3	80	.30
	4	75	.40
	5	85	

Average

i

$M_{A\,2007} = \frac{75}{3} + \frac{85}{3} + \frac{90}{3}$

$= 75 \times 0.33 + 85 \times 0.33 + 90 \times 0.33$

33.33% use every data

Weighted Moving Average

$75 \times .50 + 85 .30 + 90 . 30$

Weight different

$F_5 = 75 \times .40 + 80 \times .30 + 60 \times .20 + 40 \times .10$

$= 70$

* Exponential Smoothing method

$$F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$$

F_t = Forcast value of t period

F_{t-1} = " " " previous period of t

A_{t-1} = Actual " " " " " t

α = Smoothing constant [0.05 - 0.5]

α = [0.05 - 0.1]

α = [0.11 - 0.5]

($\alpha = 0.10$)

Quarter	Actual	Forcast
1	180	175
2	168	~~175~~ 175
3	159	174.75
4	175	173.18
5	190	173.36
6	205	175.02
7	180	178.02
8	182	178.22
9		178.59

$F_9 = F_8 + \alpha(A_8 - F_8) = 178.59$

$F_8 = F_7 + \alpha(A_7 - F_7) = 178.21$

$F_7 = F_6 + \alpha(A_6 - F_6) = 178.01$

$F_6 = F_5 + \alpha(A_5 - F_5) = 175.02$

$F_5 = F_4 + \alpha(A_4 - F_4) = 173.36$

$F_4 = F_3 + \alpha(A_3 - F_3) = 173.18$

$F_3 = F_2 + \alpha(A_2 - F_2) = 174.75$

$F_2 = F_1 + \alpha(A_1 - F_1) = 175 + \{0.10(180 - 175)\}$

$= 175.5$

$F_1 = 175$

Least square Equations

Equation : $\hat{Y}_i = a + b x_i$

slope : $b = \dfrac{\sum_{i=1}^{n} x_i y_i - n \bar{x} \bar{y}}{\sum_{i=1}^{n} x_i^2 - n \bar{x}^2}$

Y-Intercept : $a = \bar{y} - b \bar{x}$

\# Year | Demand (MW)

Year	Demand (MW)
1997	74
1998	79
1999	80
2000	90
2001	105
2002	142
2003	122

Find overall trend?

[Also find the Demand at 2004-2005]

Year	Demand (y)	x	x^2	xy
1997	74	1	1	74
1998	79	2	4	158
1999	80	3	9	240
2000	90	4	16	360
2001	105	5	25	525
2002	142	6	36	852
2003	122	7	49	854
	$\Sigma 692$	$\Sigma 28$	$\Sigma 140$	$\Sigma 3063$

$\bar{x} = \frac{28}{7} = 4, \quad \bar{y} = \frac{692}{7} = 98.86$

$$b = \frac{3063 - (7 \times 4 \times 98.86)}{140 - \{7 \times 4^2\}}$$

$= 10.53$

$a = 98.86 - (10.53 \times 4) = 56.74$

Overall trend

$y = a + bx$

$y = 56.74 + 10.53x$

at 2004, $x = 8$

at 3057, $x = (3057 - 1996)$

$$MSE = \frac{\sum (A-F)^2}{n}$$

$$MAD = \frac{\sum |A-F|}{n}$$

$$MAPE = \frac{\sum \left(\frac{|A-F|}{A} \times 100 \right)}{n}$$

Actual A	F Forecast	$\lvert A-F \rvert$	$(A-F)^2$	$\frac{\lvert A-F \rvert}{A} \times 100$
74	75	$\lvert -1 \rvert$	1	$\frac{1}{74} \times 100$
79	76	3	9	
80	78	2	4	
90	99	$\lvert -9 \rvert$	81	
105	98	7	49	
142	150	$\lvert -8 \rvert$	64	
122	120	2	4	

G.W 2.4.24

* flow time < due date → Lateness = 0
* flow time > due date → Lateness = flow time – due

SPT
EDD

Sequencing Example

Job	processing time (Ascending order)	Due date	Flow time (Cumulative processing time)	Lateness
B	2	6	2	0
D	3	15	5	0
A	6	8	11	3
C	8	18	19	1
E	9	23	28	5
	Σ28		Σ65	Σ9

SPT

(1) Avg Completion / flow time

$$= \frac{\Sigma \text{ flow time}}{\text{no. of job}} = \frac{65}{5}$$

$= 13$ days.

(ii)

$$\text{Utilization} = \frac{\text{total processing time}}{\text{total flow time}} \times 100\%$$

$$= \frac{28}{65} = 0.43$$

$$= 43\%$$

(iii)

Avg number of job in system

$$= \frac{\text{total flow time}}{\text{total processing time}} = \frac{65}{28} = 8.32 \text{ jobs}$$

(iv)

$$\text{Avg Job Lateness} = \frac{\text{Total lateness}}{\text{No of job}}$$

$$= \frac{9}{5}$$

$$= 1.8 \text{ days.}$$

EDD

Job	Processing time	Due Date	Flow time	Lateness
				0
B	2	6	2	0
A	6	8	8	0
D	3	15	11	1
C	8	18	19	5
E	9	23	28	
	Σ		Σ	$\Sigma 6$

Utilization > [Better]

Avg < [Better]

* Critical Ratio = $\dfrac{\text{Time Remaining}}{\text{Processing time}}$

CR < [Better]

$$CR = \frac{\text{Due date} - \sum \text{Processing time of completed jobs}}{\text{Processing time}}$$

Sequence	A	B	C	D	E
	6	2	8	3	9

Job	Processing time	Due Date	CR_1	CR_2	CR_3	CR_4
B	2	6	$\frac{6-0}{2} = 3$	$\frac{6-6}{2} = \boxed{0}$	X	X
A	6	8	$\frac{8-0}{6} = \boxed{1.33}$	X	X	X
D	3	15	$\frac{15-0}{3} = 5$	$\frac{15-6}{3} = 3$	$\frac{15-8}{3} = 2.3$	$\frac{15-16}{3} = \boxed{-0.33}$
C	8	18	$\frac{18-0}{8} = 2.25$	$\frac{18-6}{8} = 1.5$	$\frac{18-8}{8} = \boxed{1.25}$	X
E	9	23	$\frac{23-0}{9} = 2.56$	$\frac{23-6}{9} = 1.9$	$\frac{23-8}{9} = 1.67$	$\frac{23-16}{9} = 0.78$

* Sequencing

Job	WC_1	WC_2
A	7	2
B	9	4
C	3	5
D	1	2
E	5	8

16.4.24

Chap - 12

IPE

Operation Research

Problem formulation

linear programming

Simplex method

unknown variable

maximize/ minimize,

limitation.

Exm 2

maximize, $Z = -2x + 5y$ —

$sc \Rightarrow x$

$gc \Rightarrow y$

$x \geq 100$ — (i)

$y \geq 80$ — (ii)

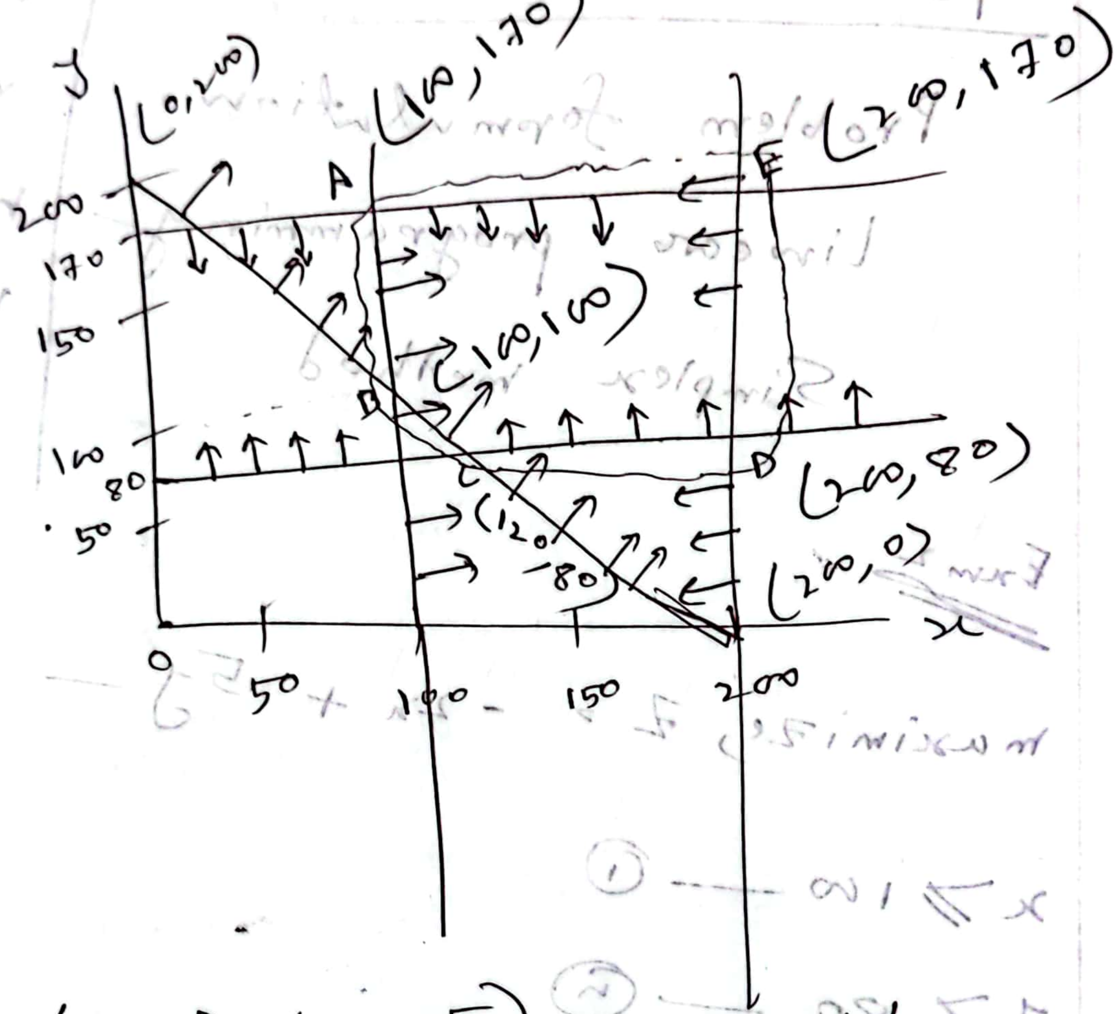
$x \leq 200$ — (iii)

$y \leq 170$ — (iv)

$x + y \geq 200$ — (v)

$(x, y) \geq 0$

P.T.O



$Z = (A, B, C, D, E)$ এসবের Value বেশি আসে সেইটাই।

P.T.O.

	x_1	x_2	x_3
x_3			1

Simplex method

θ $\frac{3}{2}$ $\frac{5}{3}$ $\frac{1}{2}$

$\frac{8}{11}$ $\frac{6}{15}$ $-\frac{1}{2}$

0 2 0 -1 0 |

3 2 0 0 1 | 18

$$Z = 3x_1 + 5x_2$$

$\frac{5}{3}+\frac{5}{2}$

$$x_1 \leq 4$$

$$2x_2 \leq 12$$

$\frac{25}{6}$

$$3x_1 + 2x_2 \leq 18$$

$$x_1 \geq 0, \quad x_2 \geq 0$$

$Z = 36$,

$(x_1, x_2) = (2, 6)$

$$Z - 3x_1 - 5x_2 = 0$$

$$x_1 + x_3 = 4$$

$$2x_2 + x_4 = 12$$

$$3x_1 + 2x_2 + x_5 = 18$$

Raph

pivot

$R_2' \times 5$

x_4 exchange x_2

	0	5	0	$\frac{5}{2}$	0	30
$R_0{}^+$	-3	-5	0	0	0	0
	-3	0	0	$\frac{5}{2}$	0	30

$R_2 \times (5) \rightarrow 0 \; 0 \; 1 \; 5 \; 0 \mid 30$

$R_0' \rightarrow -3 \; 0 \; 0 \; \frac{5}{2} \; 0 \mid 30$

$-3 \; -5 \; 0 \; 0 \; 0 \mid 0$

	Basic Variable	Eq	Z	x_1	x_2	x_3	x_4	x_5	Right side	R
R_0	Z	(0)	1	-3	-5	0	0	0	0	
(0) R_1	x_3	(1)	0	1	0	1	0	0	4	$\frac{4}{0}=\infty$
R_2	x_4	(2)	0	0	2	0	1	0	12	$\frac{12}{2}=6$
R_3	x_5	(3)	0	3	2	0	0	1	18	$\frac{18}{2}=9$
$R_0' = 5R_2' + R_0$	Z	(0)	1	-3	0	0	$\frac{5}{2}$	0	30	
(1)	x_3	(1)	0	1	0	1	0	0	4	$\frac{4}{1}=4$
$R_2' = \frac{R_2 \times 1}{2}$	$\boxed{x_2}$	(2)	0	0	1	0	$\frac{1}{2}$	0	6	$\frac{6}{0}=\infty$
$R_3' = (-2)R_2 + R_3$	x_5	(3)	0	3	0	0	-1	1	6	$\frac{6}{3}=2$
$R_0'' = R_0' + R''(3)$	Z	(0)	1	0	0	0	$\frac{3}{2}$	1	36	
	x_3	(1)	0	0	0	1	$\frac{1}{3}$	$-\frac{1}{3}$	2	
	x_2	(2)	0	0	1	0	$\frac{1}{2}$	0	6	
$R_3'' = \frac{R_3'}{3}$	$\boxed{x_1}$	(3)	0	1	0	0	$-\frac{1}{3}$	$\frac{1}{3}$	2	

Independent

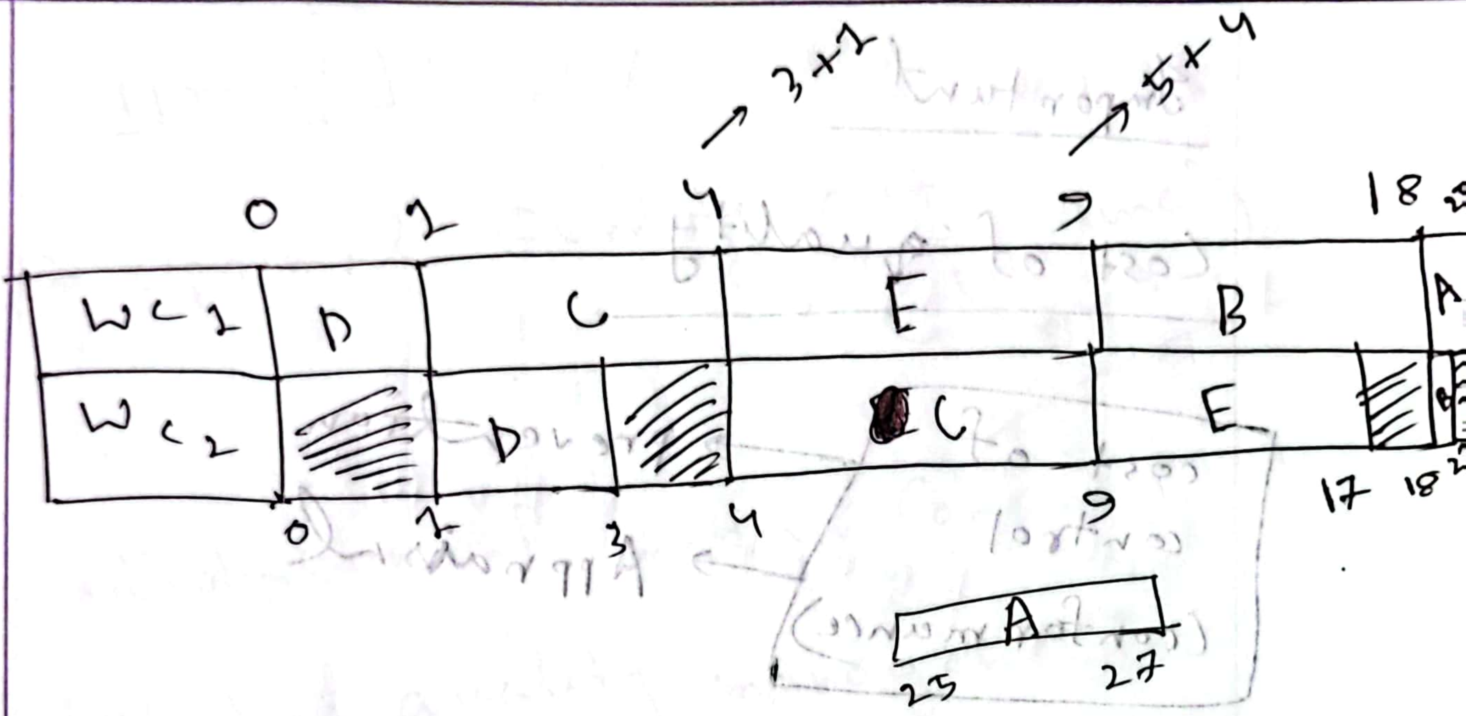
dependent

Job	WC1	WC2
A	7	2
B	9	4
C	3	5
D	1	2
E	5	8

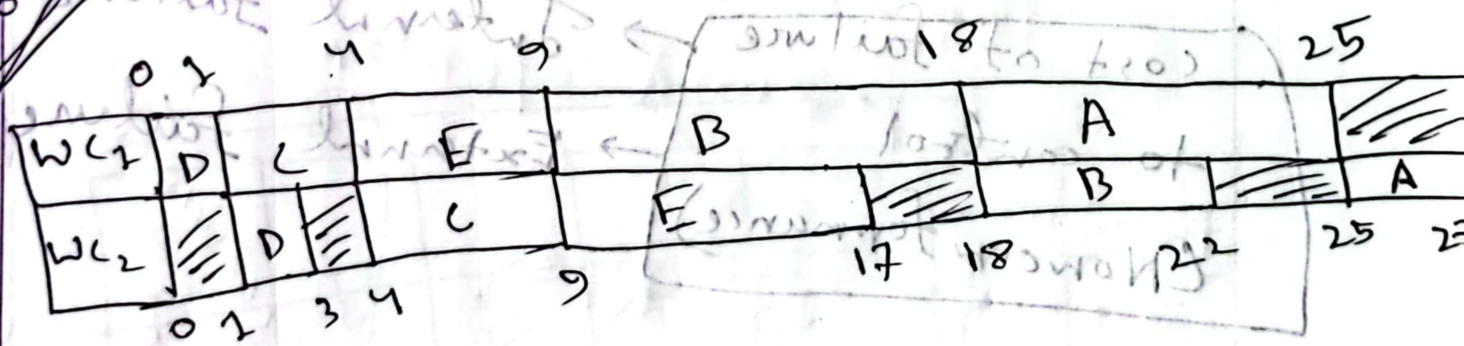
Johnson rule sequence

D	C	E	B	A
1	3	5	4	2

x Time phase diagram, idle time gant chart



Remove



B	E	D	C	A

C.W 22.4.24

C.9

TPE

Important

Cost of quality

cost of control (conformance) → prevention
→ Appraisal

cost of failure to control (Nonconformance) → Internal failure
→ External failure

* Prevention

→ Trained worker

→ Monitoring

→ Good Raw Material

→ Good machines

→ Documentation

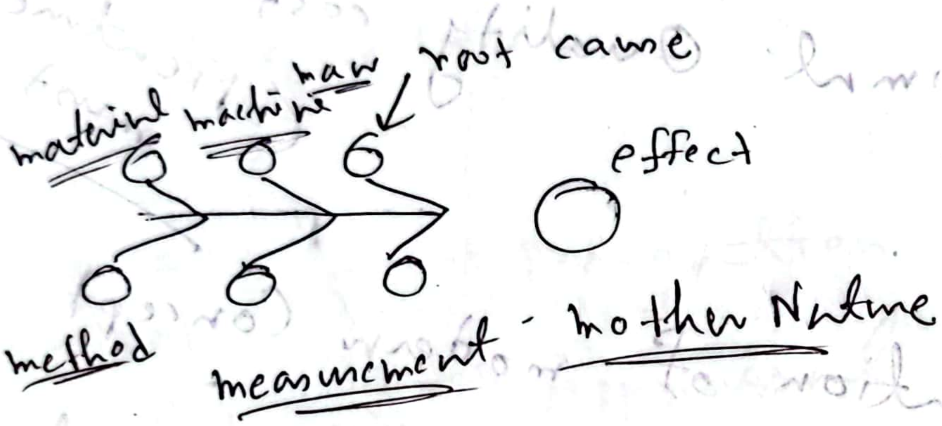
→ planning

C.W
23.4.24

IPE

* Cause Effect Diagram

6M



Man

→ Operator shortage
→ Inexperienced operator

Machine

→ Loose hose pipe

Material

Dusty raw material

Method

Improper hand pressing

* measurement

* mother nature

* Control Chart

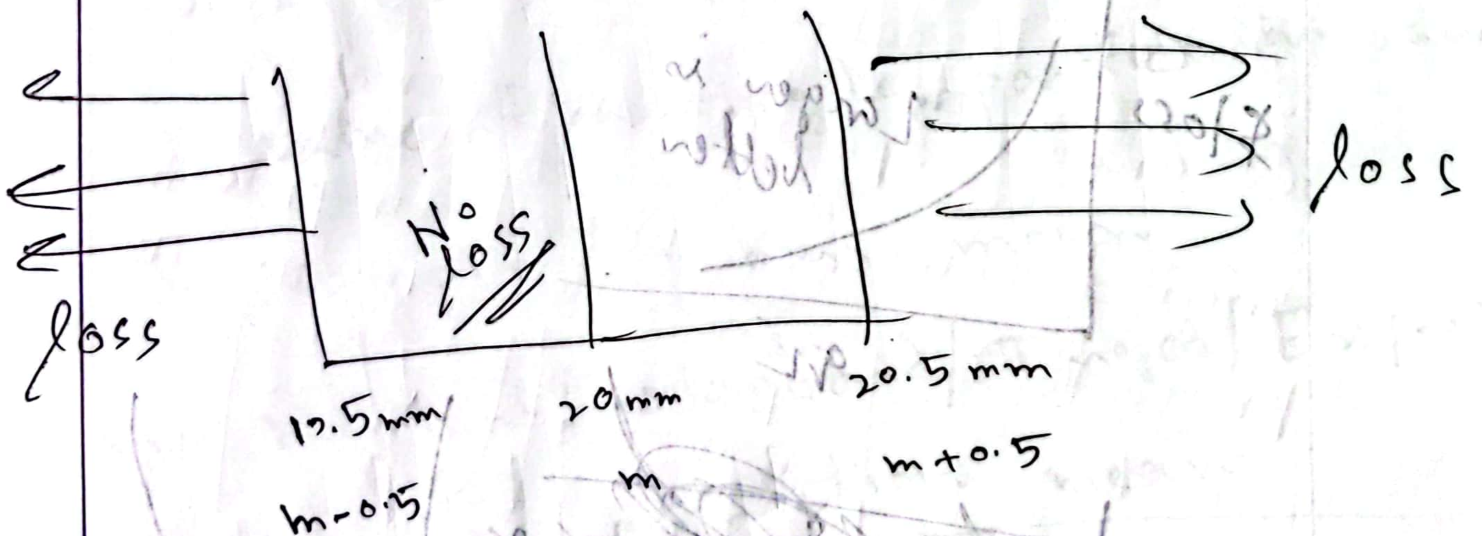
6.W
27.4.24

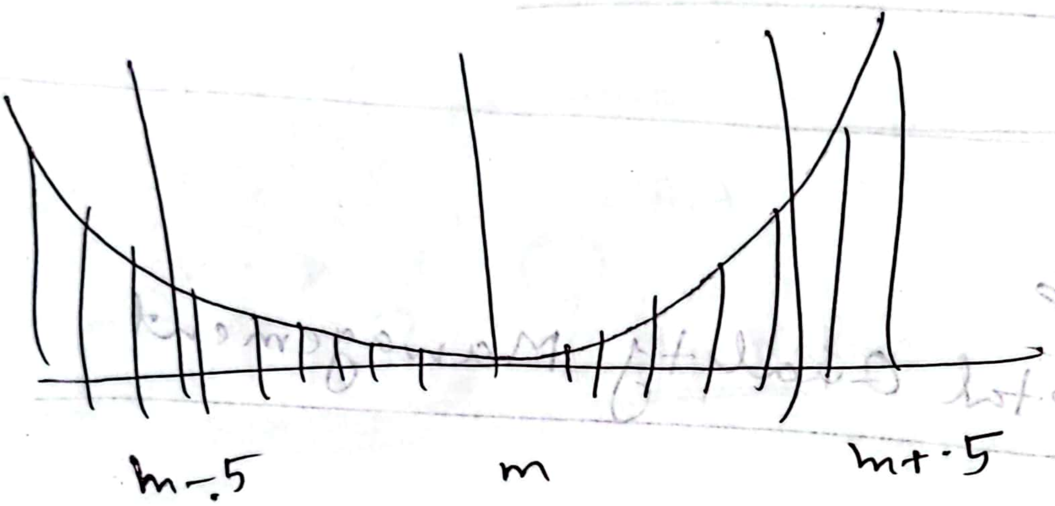
IPE

Total Quality Management

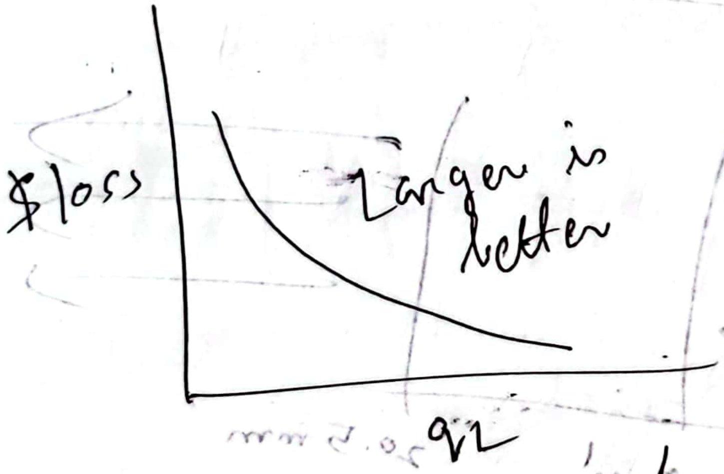
KIZEN

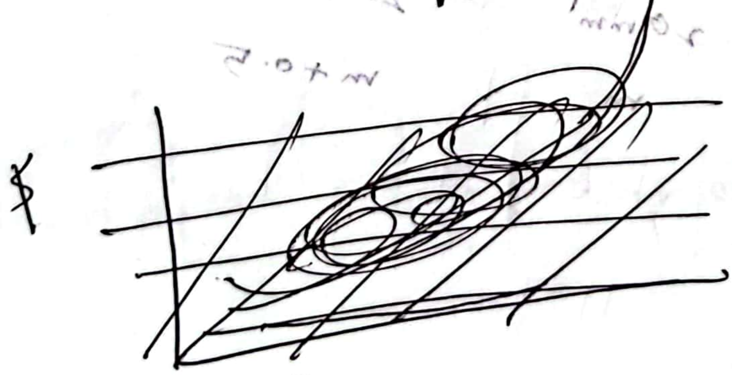
* Taguchi loss

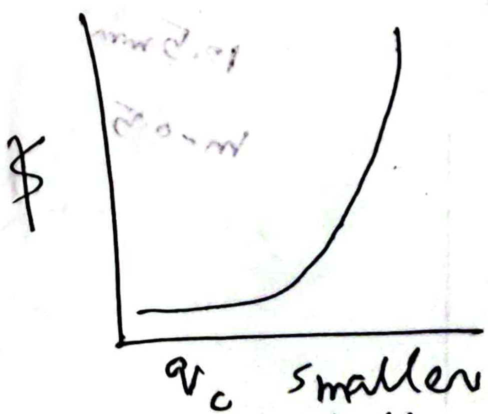




Nominal value is best







smaller is better

Problem - 1

$$L(y) = k(y-m)^2$$

$$= \frac{A}{d^2}(y-m)^2$$

$$L(\bar{y}) = \frac{A}{d^2}\left[s^2 + (\bar{y}-m)^2\right]$$

$L(y/\bar{y})$ = Total loss

A = Loss per ~~Vale~~ defect / complain (rework)

d = tolerance limit

y = value of a single / particular sample

$\bar{y}$ = sample / process mean

m = nominal / standard / Target / Expected population mean

s = standard daviation = $\sqrt{\frac{\sum_{i=1}^{n}(y_i - \bar{y})^2}{n-1}}$

$$L(y) = \frac{150}{2^2}(150-10)^2$$

$$L(\bar{y}) = \frac{2}{(0.05)^2}\left[0.016 + (8.492-8.5)^2\right]$$

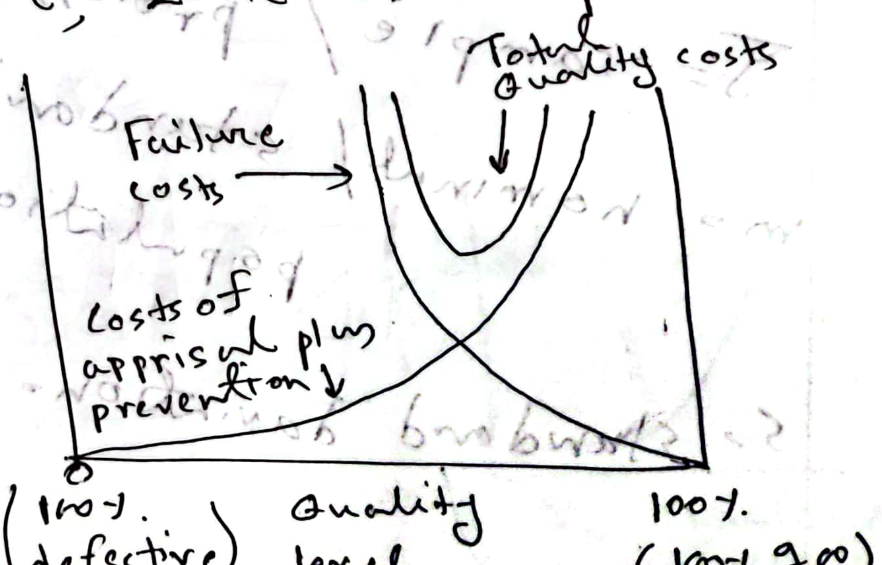
~~2~~

~~Ch-9~~

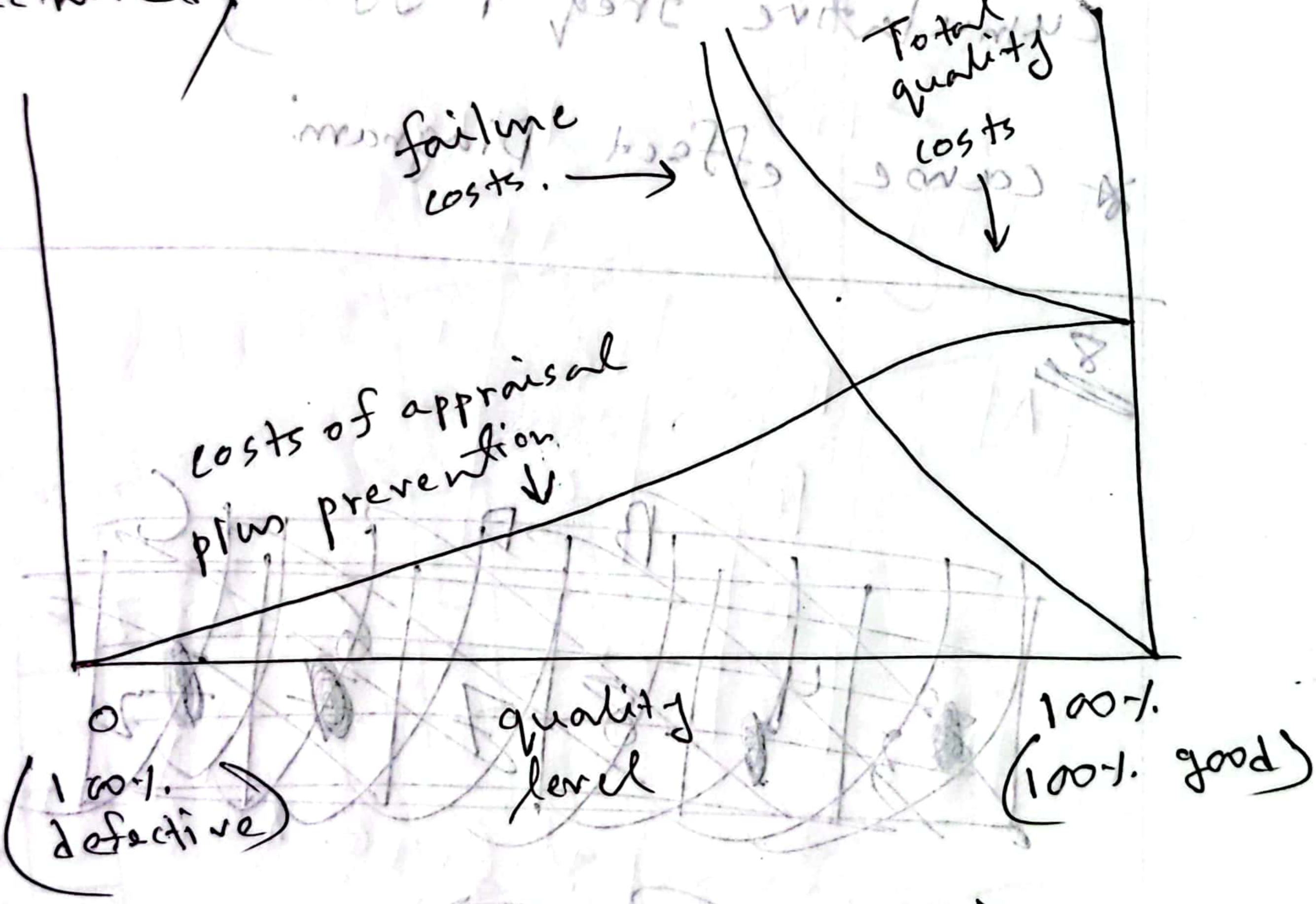
Optimum Quality Cost

Juran Model of Quality Costs

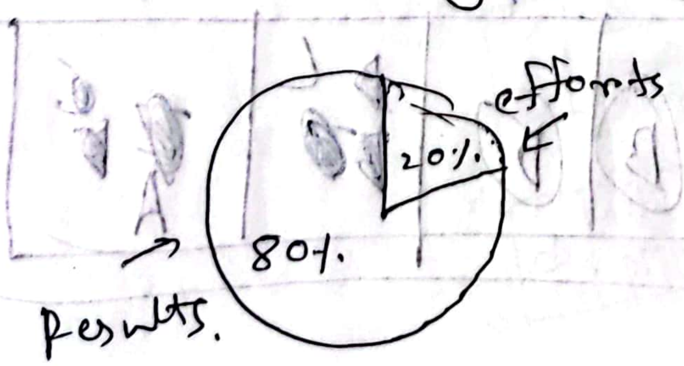
(zone of perfection, zone of indifference, zone of improvements projects)



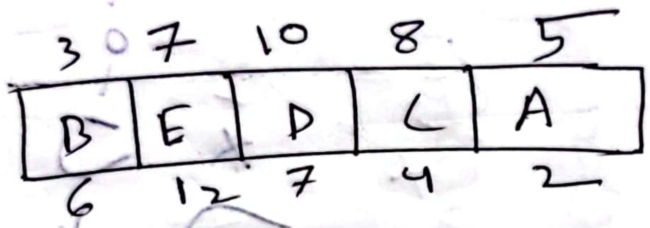
Alternative View (prevention and appraisal cost curve flattens out after a certain degree of perfection is achived)

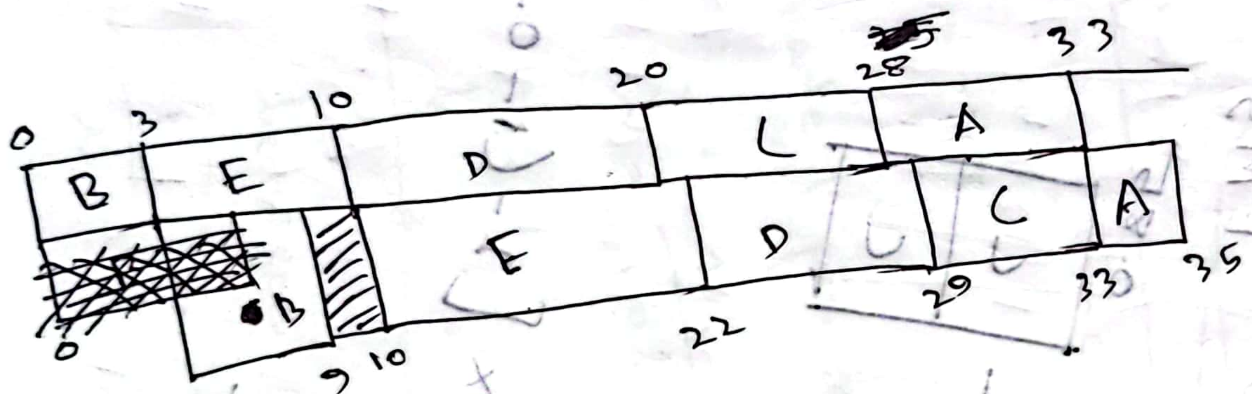


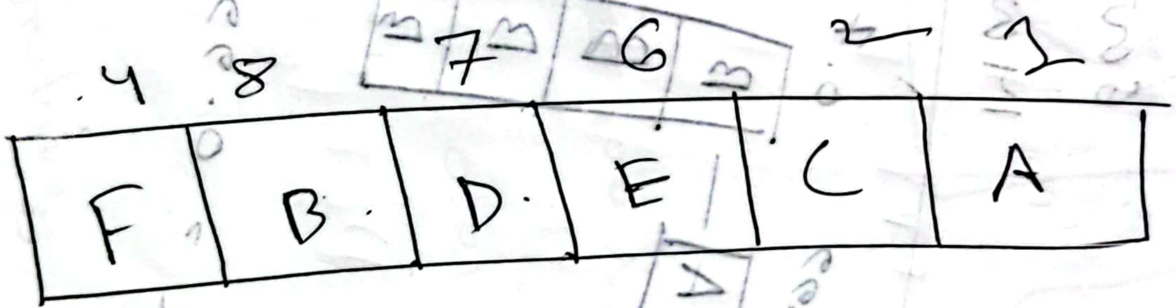
Pareto Analysis (80-20 rule)



(The secret ~~to~~ to success by achiving more with less)


3 7 10 8 5
B E D C A
6 12 7 4 2


0 3 10 20 28 33
B E D C A
B E D C A
0 3 9 10 22 29 33 35


4 8 7 6 2 1
F B D E C A

G.W 4.5.24

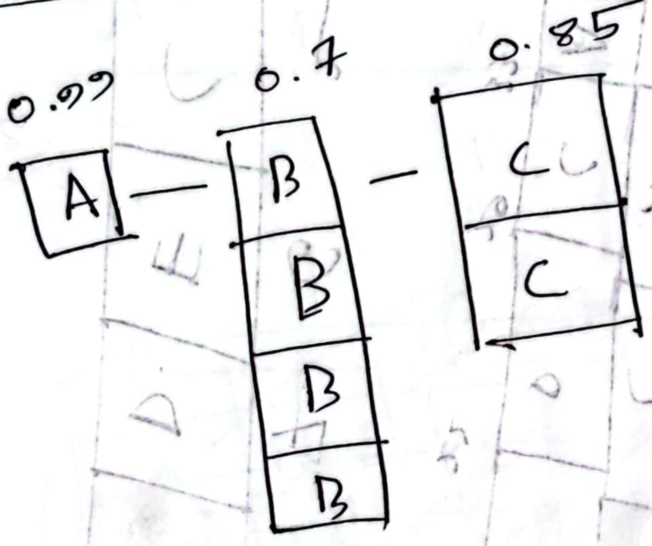
9PE

ISO

ISO 9000 QMS

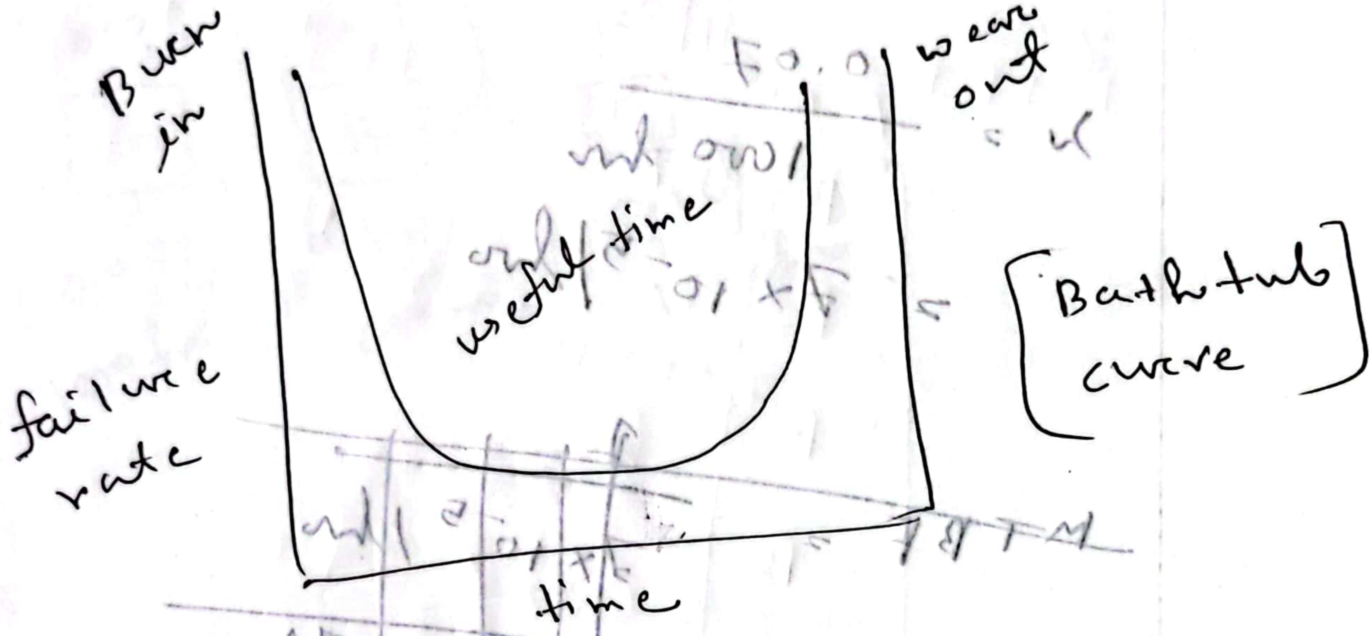
6000 safety MS

14000 EMS



$$R_c = 0.99 \times [1-(1-0.7)^4] \times [1-(1-0.85)^2]$$

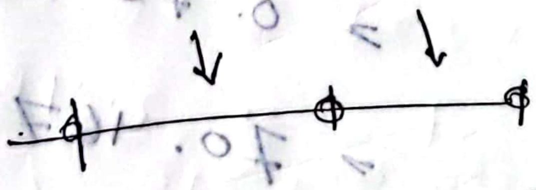
$$= 0.95$$



$R(t) = e^{-\lambda t}$

failure rate 1 per ~~hour~~ 100 hrs

$\lambda = \dfrac{1}{100\ hrs} = 0.01/hr$



Mean time between failure,

$MTBF = \dfrac{1}{\lambda} = \dfrac{1}{0.01/hr} = 100\ hr$

$$\lambda = \frac{0.07}{1000 \text{ hrs}}$$

$$= 7 \times 10^{-5} / \text{hrs}$$

$$MTBF = \frac{1}{7 \times 10^{-5} / \text{hrs}}$$

$$= 14285.71 \text{ hrs}$$

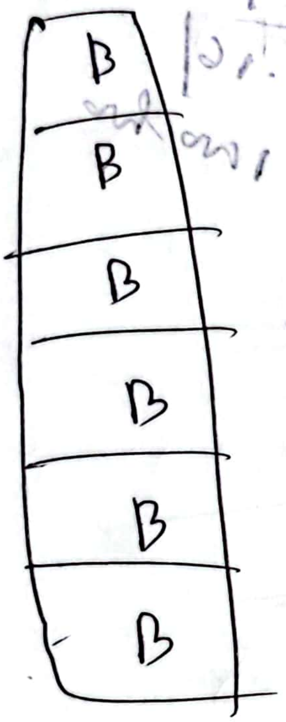
$$R(t) = e^{-\lambda t} = e^{-7 \times 10^{-5} \times 5000}$$

$$= 0.70467 \times 100\%$$

$$= 70.467\%$$

$$MTBF = \frac{1}{7 \times 10^{-5} / \text{hr}} = 14285.71 \text{ hrs}$$

$0.07/1000\ hr$



$$MTBF_{P_B} = \frac{1}{\lambda_B}\left(1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\right.$$

$$= \frac{1}{\frac{0.07}{1000\ hrs}} \times 2.45$$

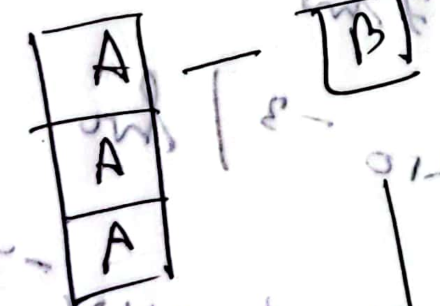
$$= 35000\ hrs$$

$$\lambda_{P_B} = \frac{1}{MTBF_{P_B}} = \frac{1}{35000 \text{ hrs}}$$

$$= 2.86\times10^{-5}/\text{hrs}$$

Reliabilities per 100 hrs ≠ failure rate per 100 hrs

$R_A = 0.75$ $\quad R_B = 0.97$



$R_B = 0.97$

$\Rightarrow e^{-\lambda_B t} = 0.97$

$\Rightarrow -\lambda_B t = \ln(0.97)$

$\Rightarrow \lambda_B = \frac{-\ln(0.97)}{100}$

$= 3.04\times10^{-4}/\text{hrs}$

$R_A = 0.75$

$\Rightarrow e^{-\lambda_A t} = 0.75$

$\Rightarrow \lambda_A = \frac{-\ln(0.75)}{100}$

$= 2.88\times10^{-3}/\text{hrs}$

$$MTBF_A = \frac{1}{\lambda_A}\left(1+\frac{1}{2}+\frac{1}{3}\right)$$

$$= \frac{1}{2.88\times10^{-3}/hr} \times \frac{11}{6}$$

$$= 636.57 \text{ hr}$$

$$\lambda_{PA} = \frac{1}{636.57 \text{ hr}}$$

$$= 1.57\times10^{-3}/hr$$

$$\lambda_{sys} = (1.57\times10^{-3}) + (3.04\times10^{-4})/hr$$

$$= 1.874\times10^{-3}/hr$$

$$MTBF_{sys} = \frac{1}{1.874\times10^{-3}/hr}$$

$$= 533.618 \text{ hr}$$