①

④ Comparative analysis of alternatives

4.1 comparing mutually exclusive alternatives having same useful life by

ⓐ payback period method and FW method
ⓑ Rate of return methods and B/C ratio method

4.2 Comparing mutually exclusive alternatives having different useful lives by

ⓐ Re-peatability assumption
ⓑ Co-terminated assumption
ⓒ capitalized worth method

4.3 comparing mutually exclusive, contingent and independent projects in combination

from the following information select the best project by using FW method and useful life is 4 years.

P.T.O

(FW, AW, PW jastro badi tehi accept)

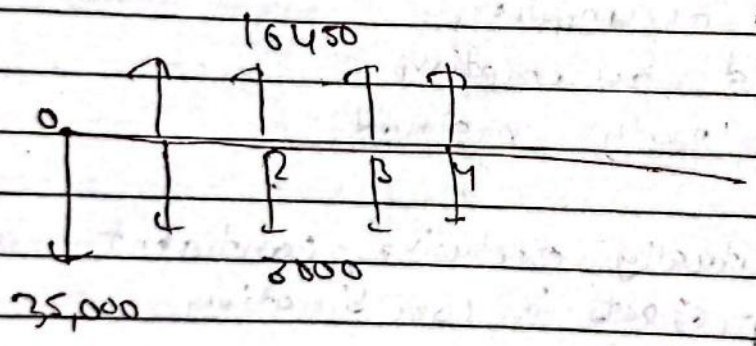
(IRR ra ERR ma ni jun thulo tei accept)

(2)

Projects	Project A	B
I	35000	50,000
A·R	16450	25000
A·C	3000	13830
Useful life	4	4
SV	0	0
MARR	10%	10%

Soln:-

For A

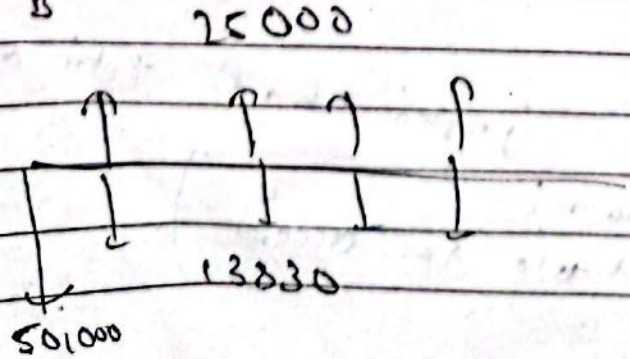


$$FW = -35,000 + 13450\left[\frac{1.1^4 - 1}{0.1}\right]$$

$$= -35000(1+0.1)^4 + 13430\left[\frac{1.1^4-1}{0.1}\right]$$

$$= 11177.95$$

For B



(2)

$(1+0.1)^4$

$FW = -50{,}000 + 11170 \left[\frac{1.1^4 - 1}{0.1}\right]$

$= 1839.97 - 21305.03$

$FW_A > FW_B$ so Select project A

$FW_A > FW_B$ (accept A)

Compute best project using using ERR (ε = 14%, MARR = 20%)

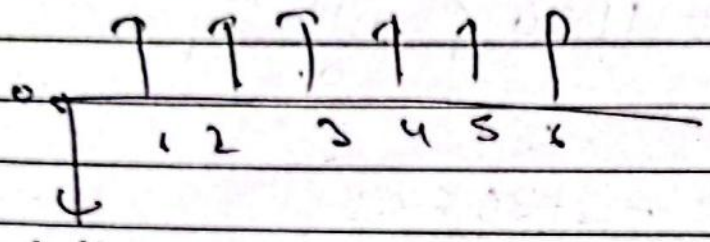
EOY	A	B
0	-6400	-7500
1	2620	2050
2	2900	4046
3	3020	4000
4	3100	3900
5	3100	3400
6	2600	3400

Soln:

For A

(4)

2620 2900 3020 3100 3100 2600



6400

Step 1

Cash OF to present

= 6400

~~Cash~~ Step 2 cash inflow to future

$= 2620 \times 1.14^5 + 2900 \times 1.14^4 + 3020 \times 1.14^3 + 3100 \times 1.14^2 + 3100 \times 1.14^1 + 2600$

$= 24579.59355$

Step 3

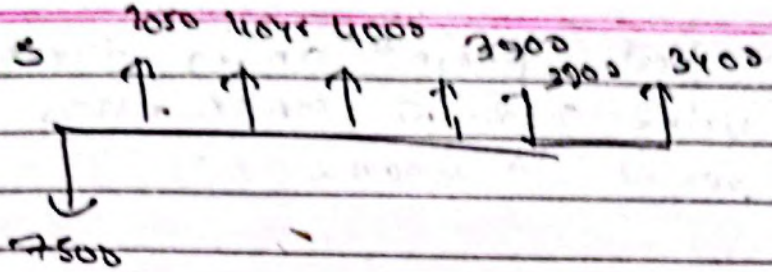
$6400 (1+i)^6 = 24579.59355$

$i = 0.2514$

$i = 2$ ERR $= 25.14\%$

(3)

For S



Step1 :

$= 7500$

step2 :

$2050 \times 1.14^5 + 4046 \times 1.114^4 + 4000 \times 1.14^3 + 3900 \times 1.14^2 + 3900 \times 1.14^1 + 3400 \times 1.14^0$

$= 29621.2487$

Step3 :

$7500 (1+i)^5 = 29621.2487$

$i = 0.2572$

$ERR = 25.72$

$ARR_2 > ERR_1$ (split Project B)

(6)

Choose the best project among these alternative using IRR if MARR = 12% and study period 10 years.

Soln:-

Project	A	B	C
First cost	2000	1500	4000
AR	390	276	925

Soln:- Eypsma just use incremental analysis if more than 2 then just use IRR method which more

For A

$$NPW = -2000 + 390\left[\frac{(1+i)^{10}-1}{(1+i)^{10}\times i}\right]$$

$NPW = 0$

Then,

$i = 0.14437$

$IRR = 14.437\%$

For B

$$0 = -1500 + 276\left[\frac{(1+i)^{10}-1}{(1+i)^{10}\times i}\right]$$

$i = 0.1296$

$IRR = 12.96\%$

(7)

For C

$i = 0.19097$

IRR = 19.097 %

(all IRR > MARR

so all can be accepted

(3 ta bha bola incremental analysis garnu parcha)

Arranging given projects in ascending order of investment B, A, C

Project	B	A	A − B	Project	C	A	C − A
First cost	500				2000		
AR	114				535		

IRR for A − B

IRR = 18.69 %

> MARR

A accept

< MARR

B accept

IRR for C − A

IRR = 23.51 %

> MARR

C accept

A reject

So finall C is accept Accepted #

Incremental analysis

Q The estimate capital investment and the annual expenses for four alternative design of diesel power air compressor are shown. The study period is five years and the MARR is 20% per year. Based on the information determine the preferred design alternative using IRR on incremental investment.

Soln :-

Design alternatives	D_1	D_2	D_3	D_4
CI	-100000	-140600	-148200	-122000
AE	-29000	-16900	-14800	-22100
n	5	5	5	5
MV (market value = SV)	10000	14000	25600	14000

So h :-

For D_1

$$\text{PW} = -100000 - 29000 \left[\frac{(1+i)^5 - 1}{i(1+i)^5}\right] + 10,000 (1+i)^{-5}$$

(9)

NPV = 0

IRR = [illegible] — 16% (reject)

For D2

$$NPW = -40600 - 16900\left[\frac{(1+i)^5 - 1}{(1+i)^5 \times i}\right] + 14000(1+i)^{-5}$$

IRR =

Arranging according to investment cost

D1, D4, D2 and D3

Take D1 as best alternative

And	D4 − D1	D2 − D4	D3 − D4
C.I	−22000	−18600	~~−7600~~ 26200
A.E	6900	5200	~~2100~~ 7300
S.V	4000	0	~~14600~~ 11600

For For D4 − D1

(10)

$NPV = -22000 + 6400 \left[\frac{(1+i)^5 - 1}{(1+i)^5 \times i} \right] + 4000 [1+i]^{-5} = 0$

$IRR = 0.2047 = 20.47\% > MARR$

(Accept D_4, reject D_1)

For $D_2 - D_4$

$NPV = -18600 + 5200 \left[\frac{(1+i)^5 - 1}{(1+i)^5 \times i} \right] = 0$

$= 12.31 < MARR$

(Reject D_2, accept D_4)

For ~~$D_3 - D_2$~~ $D_3 - D_4$

$NPV =$ ~~7600~~ $23200 + 7300 \left[\frac{(1+i)^5 - 1}{(1+i)^5 \times i} \right] + 11600 (1+i)^{-5} = 0$

$IRR = 25.4\%$

(select D_3, reject D_4)

∴ D_3 is the best alternative #

(4 wota aayo bhone ~~sath~~ chutta chuttai IRR nanikalne 3 ta ma nikalne #)

(11) (payback less is accepted)

From the following four mutually exclusive project determine the best one project using a) Discounted payback period c) BCR methods. The study period is 5 year and MARR = C = 15%.

project	A	B	C	D
I.I	500 000	400000	700 000	600 000
AR	125000	110000	170000	135 000

S.V = .20% of I.I

(i) Discounted pay Back period:

For For project A (many)

EOY	C.F	P.W C.F	Cun CF
0	-500000	-500000	-500000
1	125000	108695.65	-391304.35
2	125000	94517.95	-296786.4
3	125000	82189.52	-214596.88
4	125000	71469.15	-143127.73
5	125000	62147.09	-80980.64
	+ 100 000 (SV)	111864.76	-312 13.96

~~Project A~~

Payback period is more than 5 yrs

(13)

For B

Box	CF	PW	Cum C.F
0	-400000	-400000	-400000
1	110000	95652.17	-304347
2	110000	83175.80	-221172.
3	110000	72326.78	-148845.
4	110000	62892.85	-85952.
5	190000	94463.57	8511.17

Payback period lies in 4-5

$$x = x_1 + \frac{(y-y_1)(x_2-x_1)}{(y_2-y_1)}$$

$$= 4 + \frac{(0+85952.4)(5-4)}{(8511.17+85952.4)}$$

$$= 4.90$$

(4)

For C

BOY	CF	PW	Cum C.F
0	-700 000	-700 000	-700,000
1	170 000	147826.087	-552173.913
2	170 000	128544.42	-423629.493
3	170 000	111777.75	-311851.74
4	170 000	97198.051	-214653.69
5	310000	154124.78	-60528.912

Payback period is more than 5 yrs

For D

BOY	CF	PW	cum CF
0	-600,000	-600,000	-600,000
1	135,000	117391.30	-482608.7
2	135,000	102079.39	-380529.31
3	135,000	88764.69	-291764.62
4	135,000	77186.68	-214577.94
5	255000	176780.06	-87797.88

payback period is more than 5 yrs #

(13)

least payback period is B so B is accepted

2nd B/C method

For project A

B/C ratio = pw of benefit / pw of cost

pw of benefits = $125000\left[\frac{(1+i)^5-1}{(1+i)^5 i}\right]$ + $100,000(1+i)^{-5}$

i = 15% , n = 5

= 468737.06

pw of costs = 500,000

B/C = $\frac{468737.06}{500,000} = 0.93 < 1$

so reject

(6)

For project B

pw of benefits =

+ 80,000 (+

=

B/C ratio =

110,000

= 110,000 [1.15 / 1.1

400,000 =

= 1.02 > 1

Project C

→ 0.90 <

Project D

→ 0.83 < 1

(so B is accep

(if 2 are
ratio is

16

For project B

PW of benefits = 110000 $\left[\frac{1.15^5 - 1}{1.15^5 \times 0.15}\right]$

+ 80,000 $(1+0.15)^{-5}$

=

B/C ratio = $\frac{\text{Benefit}}{\text{cost}}$ =

non

110,000

= 400,000 $\left[\frac{1.15^5 - 1}{1.15^5 \times 0.15}\right]$

400,000 − 80,000 $(1+0.15)^{-5}$

= 1.02 > 1 (accepted)

Project C

→ 0.90 < 1 (reject)

project D

→ 0.83 < 1 (reject)

(so B is accepted). #

(if 2 are above 1 the highest B/C ratio is selected)

(17)

Repeatability assumption (LCM of useful life)

→ Two or more alternative having different useful life are changed into projects having same useful life by expanding their life up to at least common year.

(1) The following data have been estimated for two feasible investments X and Y having different useful lives. If minimal attractive rate of return is 10% choose the best one project using PW method. Use repeatability assumption.

Alt	X	Y
C.I	-3500	-5000
A.R	1800	2500
A.E	-645	-1020
Useful life	4	6
SV	0	0

Soln:

(FW and AW)

ni same garna milcha

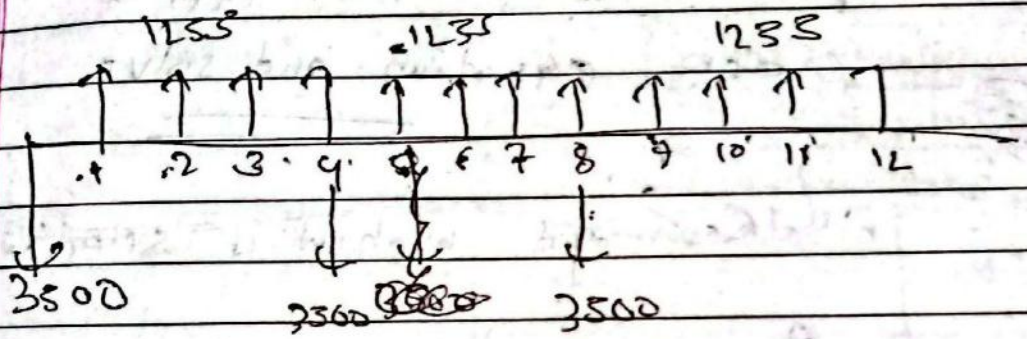
(18)

L.C.M at (4,6) = 12

2 | 4, 6
2 | 2, 3
3 | 3
| 1

= 12

For X (4×3 = 12 (3 times repeat)

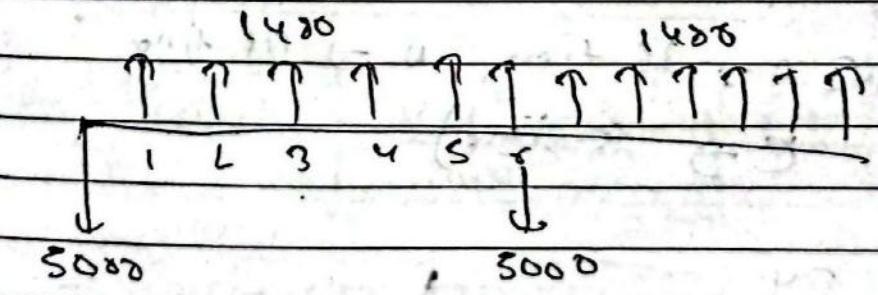


PW = -3500 + 1255 (APIA, i%, n)

- 3500 (PIF, i%, n) - 3500 (PIF, i%, n)

= 1028 #

for Y (6×2 2 times repeat)



PW = -5000 - 800 (1+0.1)$^{-6}$ + 1480 $\left(\frac{1.1^{12}-1}{1.1^{12}\times 0.1}\right)$

= 2261.89

PW$_X$ > PW$_Y$ (so X is best)

(Q) (4 chati bhanda badi repat garna parne condition aayo bhane do not use repeatibility analysis)

Select the project using AW method make equation and solve.

~~A = hi~~ and highest is selected

	A	B	C
I	100,000	200,000	250,000
B	25,000	20,000	15,000
n	3	5	7
S.W	40,000	50,000	60,000
MARR	14%	14%	14%

L.C.M of 3, 5, 7 = 105

(A → 35 times, B → 21 times, C → 15 times)

For A

$$PW(14\%) = \sum_{x=0}^{34}\left(\frac{-100,000}{(1+i)^{3x}}\right) - \frac{25,000 \times ((1+i)^{105} - 1)}{i \times (1+i)^{105}}$$

$$+ \sum_{x=1}^{35}\left(\frac{40,000}{(1+i)^{3x}}\right)$$

(20)

PW(14%) = [redacted]

= − 403170.2074

For B (21 times repeat)

$$PW(14\%) = \sum_{x=0}^{20} \left(\frac{-200{,}000}{(1+0.14)^{5x}} \right)$$

$$= -20{,}000 \left[\frac{1.14^{105} - 1}{1.14^{105} \times 0.14} \right] + \sum_{x=0}^{21} \left(\frac{50{,}000}{1.14^{5x}} \right)$$

= − 504946.13

PW(14%) For ((15 time repeat)

$$PW(14\%) = \sum_{x=0}^{14} \left(\frac{-250{,}000}{(1+0.14)^{7x}} \right)$$

$$= -15{,}000 \left[\frac{1.14^{105} - 1}{1.14^{105} \times 0.14} \right] + \sum_{x=1}^{15} \left(\frac{60{,}000}{1.14^{7x}} \right)$$

= −483617.7141

Here,

PW_A > all

So,

A is the best selection #

(4)

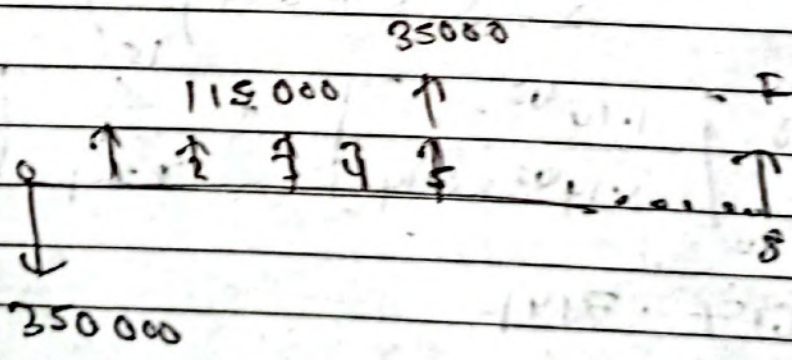
A → co-terminate assumption
Used when repeatability assumption is not applicable.

(5) Study period > useful life

Using co-terminate assumption recommend the best project taking study period as 8 yrs.

Projects	A	B
I.I	350000	500000
A.R	130000	175000
A.C	15000	25000
S.V	35000	50000
U.L	5	8
MARR	10%	10%

For A



$$FW_5 = -350000(1+0.1)^5 + 115000\left[\frac{1.1^5-1}{0.1}\right] + 35000 = 173405$$

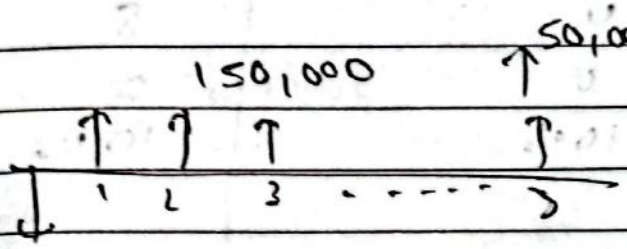
(12)

$FW_A = 173408 \times 1.1^3$

$= 230806.04$

for B

Study period = useful life



$$FW_B = -500{,}000(1+0.1)^8 + 150{,}000\left(\frac{1.1^8-1}{0.1}\right) + 50{,}000$$

$= 693589.81$

$FW_B > FW_A$ (accept B)

(b) when study period < useful life

Imputed MV calculation (salvage value calc)

$MV = PW_{CR} + PW_{MV}$

PW_{CR}: capital recovery to PW of given study period

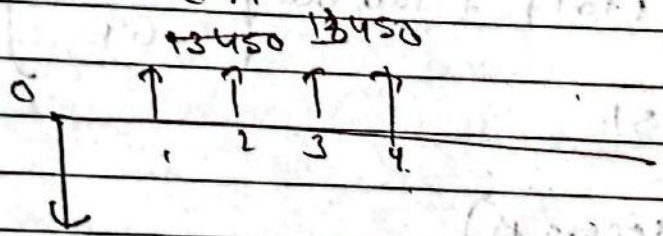
PW_{MV}: present worth of current SV to given study period

(23) (study period = 4 years)

Project	A	B
I.I	35000	50 000
A.R	16450	23000
A.C	3000	13830
useful life	4	8
SV	0	0
MARK	10%	10%

For A

For A



PW A = ~~7634.68~~

PW A = 11177.85 = 11178

For B

CR = I (A/P, 10%, 8) − SV (A/F, 10%, 8)

= 50,000 (A/P, 10%, 8) − 0 (A/F, 10%, 8)

9370

PW at 4th year (data study period)

$PW_{CR} = 9370\ (P|A, 9\%, 4)$

$= 29702$

S.V = 0

at 4 year

M.V = $PW_{CR} + PW_{MV}$

$= 29702 + 0 = 29702$

A = 11870 29702

1 2 3 4

50,000

$FW_B = 8337$ (at 4)

$FW_A > FW_B$

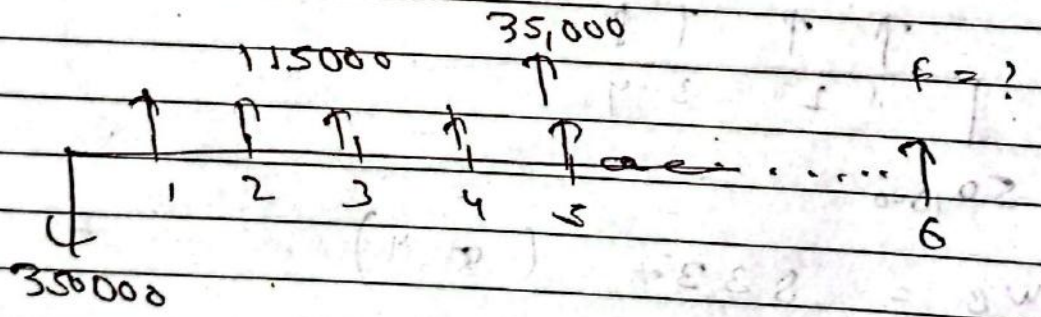
(So select B)

Recommend the best project from the following two projects taking study period as 6 yrs. Assume MARR = 10% per year.

Project	A	B
I	350000	500000
A.R	130000	175000
A.C	15000	25000
S.V	35000	50000
Useful life	5 yrs	8 yrs

For A

study period > useful life.



$$FW_5 = -359000\,(1+0.1)^5 + 115000\left(\frac{1.1^5-1}{0.1}\right) + 35{,}000$$

$$= 60\,680718.65 \;?$$

$$FW_6 = 74\,890.515 \rightarrow 100748.8$$

For B

6 8

study period: C US+tal 1;fi

$CR = I(A/P, 10\%, 8) - S.V(A/F, 10\%, 8)$

$= 500{,}000\left[\frac{1.1^8 \times 0.1}{1.1^8 - 1}\right] - 50{,}000\left[\frac{0.1}{1.1^8 - 1}\right]$

$= \$\ 89349.8079$ | study period

6

PW_{CR} at 6 $= 89349.80$ $(P/A, 10\%, n)$ $^{-2}$

$= 155059.9008$

PW_{SV} at 6 $= 50{,}000 \times 1.1^{-2}$

$= 41322.3140$

$IMV = PW_{CR} + PW_{SV}$

$= 113842.8 + 41322.3$ | 196392.2149

$= 115165.124$

150000 | 115165.124 | 196392.2149

1 2 3 4 5 6

500,000 | 467953.2149

$FW = 386{,}726.124$ ~~$= 72506.602$~~

(select B)

FV B > FW A

$CW = \frac{AW}{marr}$

Capitalized worth method : (AW)

① Solve by capitalized worth method and select.

	A	B
I.C	-50,000	120 000
A.R	10,000	10,000
A.C	9000	6000
Useful life	10	25
MARR	15%	15 %

Calculate AW.

~~AA~~ $AW_A = -50,000 (A|P, i\%, 10) +$
$10,000 - 9800$

$= -8962.60$

$CW_A = \frac{AW_A}{marr} = \frac{-8962.80}{0.15} = -59750.68$

$AW_B = -120,000 + 10,000 (A|P, i\%, 25)$
$+ 10,000 - 6000$

$= -14563.92$

$CW_B = \frac{-14563.92}{0.15} = -97092.855$

$(NPV)_A > (NPV)_B$ (Select A)

Comparing Mutually Exclusive, contingent and Independent projects in combination

Mutually exclusive project

only one project can be choosen from the group of projects.

Eg: Mutually exclusive project A, B, C

Mutually exclusive combination	Explanation	project A	B	C
1	Do nothing	0	0	0
2	Accept A	1	0	0
3	" B	0	1	0
4	" C	0	0	1

Independent project

choice of one project is independent of choice of any other project. All or none or some project can be selected.

Eg: Independent project A and B

(29)

15.

Mutually exclusive combination	Explanation	Project	
		A	B
1	Do nothing	0	0
2	Accept A	1	0
3	" B	0	1
4	" A&B	1	1

(3) Contingent project

→ The choice of a project is conditional on the choice of one or more other project.

Eg: Suppose on 3 project C is contingent on acceptance of B and acceptance of B is contingent on acceptance of A.

Mutually exclusive	A	B	C
1	0	0	0
2	1	0	0
3	1	1	0
4	1	1	1

C line
B line paryo
B lai A line xaina

C lai

Some engineering projects are being considered as following cash flows estimation over four years as shown in table below. Determine what combination of project is best if the capital to be invested is (a) Unlimited (b) limited to Rs 50,000 by using the PW method and MARR = 10% per year.

Project	B_1	B_2	C_1	C_2	D
I.I	50,000	30,000	14,000	15,000	10,000
A.S	20,000	12,000	4000	5000	6000

B_1 and B_2	mutually exclusive
C_1 and C_2	mutually exclusive and contingent on acceptance of B_2
D	contingent on acceptance of C_1 and B_2

Soln:-

mutual exclusive condition	project B_1	B_2	C_1	C_2	D
1	1	0	0	0	0
2	0	1	0	0	0
3	0	1	1	0	0
4	0	1	0	1	0
5	0	1	1	0	1
6	0	0	0	0	0

(31)

combined project

Items	mutually exclusive combinations					
	1	2	3	4	5	6
	B_1	B_2	B_2+C_1	B_2+C_2	B_2+C_1+D	0
I.I	50,000	~~44,000~~	~~45000~~	30		
A.K	20,000	~~16,000~~	~~17000~~			

n = 4 yrs

Items	mutually exclusive combination					
	1	2	3	4	5	6
	B_1	B_2+C_1	B_2+C_2	B_2	B_2+C_1+D	0
I.I	50,000	44,000	45,000	30,000	54,000.	0
A.R	20,000	16,000	17,000	12,000	22,000	0

All (1-6) combination ko PW

PW_1 = ~~42820~~ 13397.30, PW_2 = ~~30256~~, 8717.87

8887.715 PW_3 = ~~33897~~, PW_4 = ~~25692~~ 8035.38

PW_5 = ~~48102~~ 13,737.03 PW_6 = 0

PW_5 is greatest

So, combination (B_2+C_1+D) is best #

If investment is upto 50,000

reject combination 5 (8 = 54,000)

So 1 is best in investment upto 50,000

↓

B_1