CAPITAL BUDGETING
(Investment Decisions)

Learning objectives

* Average rate of return (or) Accounting ROR (ARR)
* Pay back period
  - with discounting
  - without discounting
* Net present value (NPV)
* Internal ROR (IRR)
* Profitability index (or) Benefit cost ratio (PI)
* CF estimation and decision making
* NPV vs IRR (conflict)
  - Life disparity (concept of EAB & EAC)
  - Timing / CF disparity (concept of MNPV & MIRR)
* Capital rationing
  - Divisible projects & Indivisible projects
  - Capital rationing with Idle funds
  - Capital rationing with delayed start
* CT-fund approach vs ESH approach

Introduction to capital budgeting concept

1. Features of capital budgeting

Feature	Analysis
1. Long-term investment decision	* Capital budgeting is all about long-term investment decision. * It has a long-term impact. * The cash-flow streams is as follows —— • Huge out flow today. • series of inflows in future. * Multiple & * Uneven. * Examples: • Buying a new machine • Replacing old machine

	· opening new factory · R&D in automobile Pharma
2. Irreversable	* once a CB decision is taken, it is irreversible. once a decision is taken on this kind of investments, we can't take back expect with a huge loss.
3. very risky	* It is risky because, the O/F is huge. * It is risky because, the I/F are uncertain & unguaranteed. * It affects the MPS of the company * It is risky because time is very long and we need to forecast the future. * It is risky because, it affects the liquidity.

2. Types of capital budgeting decisions

Type of decision	Analysis
a. Accept – Reject decision	* we will accept good projects. * we will reject bad projects. Example: company has a policy that all projects with 10% return will be accepted. So, if multiple projects are expected to give 10% ROR, all will be selected.

b. Mutually exclusive decision — In this case accepting of one project will lead to reject decision. Project that gives best CF & ROR will be selected.

c. Capital rationing decision — It is accept reject only, but with constraints.

Example :-

Company considering 5 projects costing 1,500 crs but company has only ₹1000 crs.

3. Data relevant for capital budgeting decision

A. Consider cash flows not accounting profits

* Generally, we accept any project if we get income more than costs.
* But, in CB, benefit is not income rather it is "cash inflow" and costs is not expenditure, rather it is "cash outflow".

Accounting profits vs cash flows – The superiority

1. Accounting profits are based on various estimates assumptions, and principles. It differs from person to person. That means, profit for one person need not be same profit for another.

CA – 1		CA – 2
• SLM		• WDV
• FIFO		• LIFO
• 10 years goodwill write off		• 5 year goodwill write off.
Profit	≠	Profit

But cash of ₹10,00,000 is same for any one since cash flow is not subject to assumptions.

2. Accounting profits are not subjected to TVM. That means, one cant apply the concept of TVM on profits because of 2 reasons ——

- TVM being PV factor is made out of 2 elements namely ——

  * Inflation
  * opportunity cost.

  out of these 2, inflation can be applied only on CFs and not on the profits because, the profits contain lot of non CFs on which one can't apply inflation.

- Another reason is, we analyse project as the difference b/w total realisation less initial investment. In this, initial investment is met today as a cash outflow, and therefore, the total realisation should also be expressed in CF terms only but not in terms of profits.

3. whenever, we start analysing the projects, we will first analyse the return (%) that the project is expected to give. But, return is given only on cash flow but not on paper profits.

<u>Example</u>

Deposit of cash ₹10,00,000 v/s Deposit of P&L statement having audited profits of same ₹10,00,000.

B. Donot consider all cash flows, consider only the <u>incremental CFs.</u>

* while analysing a CB decision, consider only the incremental CFs but not all the CFs.
* costs that are common across any project should not be considered.

C. Cash flows considered should be after tax.

* whenever, we consider any project, it should be considered after tax.
* The moment a project gives a CF, a portion of it shall be paid to the government in form of tax.
* So, project CFs should be understood as Net Cash inflows = (Cash inflow p.a − Cash outflow p.a) × (1−t)
* In simple, all inflows result in tax outflows and all OFs result in tax inflows (savings). So, when we consider Net cash flows, we will also to consider net taxes.

D. Consider the cash flows after taking depreciation.

* Depreciation is always considered as non cash item and as a mere book entry and therefore not a real cash flow. It is true but one should not totally ignore the depreciation and this can be explained with an eg:

Particulars	Project - A	Project - B
Sales	₹ 5,00,000	₹ 5,00,000
(−) Production costs	(₹ 3,00,000)	(₹ 3,00,000)
EBDIT	₹ 2,00,000	₹ 2,00,000
(−) Depreciation	(₹ 1,00,000)	(₹ 80,000)
EBT	₹ 1,00,000	₹ 1,20,000
(−) Tax @ 30%	(₹ 30,000)	(₹ 36,000)
EAT	₹ 70,000	₹ 84,000
Ranking	II	I

* As per the CF schedule above, (project) we will select Project B in priority to project A. But this comparison is wrong because we are not considering the CFs but the profits.
* Though depreciation is a non cash item, it will give a tax saving @ 30% which should be surely considered.
* Situation after adding back depn is as under—

Particulars	Project - A	Project - B
Sales	₹ 5,00,000	₹ 5,00,000
(-) Production costs	(₹ 3,00,000)	(₹ 3,00,000)
EBDIT	₹ 2,00,000	₹ 2,00,000
(-) Depreciation	(₹ 1,00,000)	(₹ 80,000)
EBT	₹ 1,00,000	₹ 1,20,000
(-) Tax @ 30%	(₹ 30,000)	(₹ 36,000)
EAT	₹ 70,000	₹ 84,000
(+) Depreciation	₹ 1,00,000	₹ 80,000
Cash inflow	₹ 1,70,000	₹ 1,64,000
Ranking	I	II

Just by adding back the depreciation, the project preferences are changed. This is due to impact of tax savings on depreciation.

* what if, one totally ignores the depreciation instead of deducting first and adding it back.

Particulars	Project - A	Project - B
Sales	₹ 5,00,000	₹ 5,00,000
(-) Production costs	(₹ 3,00,000)	(₹ 3,00,000)
EBT	₹ 2,00,000	₹ 2,00,000
(-) Tax @ 30%	(₹ 60,000)	(₹ 60,000)
EAT	₹ 1,40,000	₹ 1,40,000
Ranking	Both are equally good	

Decision is indifferent but the amounts are experiencing a fall. This is due to ignoring tax savings.

E. Cash flows to be adjusted to side affects

* whenever a project needs to be analysed, we should not just analyse that projects CFs but also the after affects of that project.
* Let us consider an example as under ——

	Project A	Project B
Cash inflow p.a	₹ 1,00,000	₹ 95,000
Repairs p.a	₹ 15,000	–

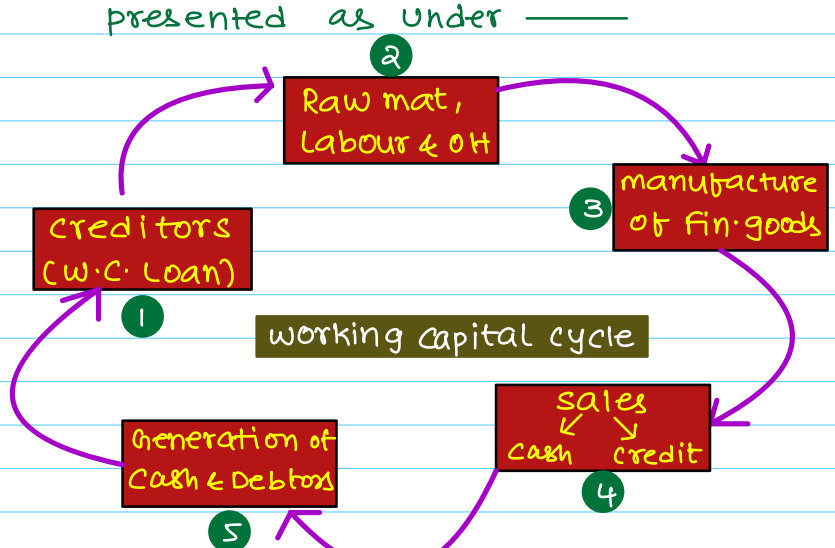
Though CFAT are more in project A than in 'B' it has yearly repair costs which is not there in project B.

F. working capital adjustment

* working capital is the capital required to carry out day-to-day operations.
* Capital budgeting decision involve huge intial out Lay in the form of ———
  - Land
  - properties
  - Plant
  - Equipment etc.

but those outlay by itself donot generate any cash in-flow. cash inflow will get generated only if these are used in the production cycle. This is also called as "working capital cycle".

* This working capital impact can be pictorially presented as under ———



* Net w. cap will be same every year (assumed) during '0' year we invest in w.cap and it will come back in hand only at end of last year.

(I 1.) **Step 1** **Calculation of depreciation p.a.**

Since ABC Ltd follow SLM method of depreciation,

$$\text{Depreciation p.a.} = \frac{\text{Cost of asset} - \text{Salvage value}}{\text{Life}}$$

$$= \frac{₹\,1,00,000 - 0}{4}$$

$$= ₹\,25,000 \text{ p.a.}$$

Step 2 **Calculation of cash inflow**

Particulars	Years (₹)			
	1	2	3	4
EBDIT	45,000	30,000	25,000	35,000
(-) Depn	(25,000)	(25,000)	(25,000)	(25,000)
EBT	20,000	5,000	0	10,000
(-) Tax @ 20%	(4,000)	(1,000)	0	(2,000)
EAT	16,000	4,000	0	8,000
(+) Depn	25,000	25,000	25,000	25,000
Cash inflow	41,000	29,000	25,000	33,000

4. Capital budgeting techniques

- Non-discounting techniques
  - ARR
  - Pay back
- Discounting techniques
  - NPV
  - IRR
  - PI
  - Disc. Payback
  - EAB/EAC

Accounting/ Average rate of return

* This model is also called as "Book rate of return" model.
* It measures average annual net income of any investment as a percentage of investment.
* The 2 popular formulae for calculating ARR is as under ——

$$\frac{\text{Avg. PAT}}{\text{original invst}} \times 100$$

$$\frac{\text{Avg. PAT}}{\text{Avg. invst}} \times 100$$

Average investment

=

[(original investment – salvage value)/2] + salvage + w.cap

* whenever, company want to make an investment, first thing it desires to know is return on the investment. The projects are done for the benefit of shareholders and SH expect a return called as "PAT".
* The formula for ROI% to SH is ——

$$\frac{\text{Return}}{\text{Investment}} \times 100$$

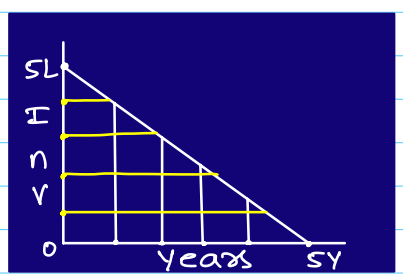
PAT

original/Avg.

* However, when a project is started, the project will not just have one cash flow, it has multiple cash inflows. Therefore, it is not correct to consider just one year/any year CFs. So, we calculate the average PAT.
* A part from above said 2 formula, there is yet another 3rd formula which is calculated on annual basis, ——

$$\frac{\text{PAT}_{p.a}}{\text{opg. invst p.a}} \times 100$$

* Formula-1 is not considered so much appropriate because, it considers Avg PAT for same intial investment for all years of project. Actually, the investment suffers depreciation which reduces the value of investment year-after-year. But that formula considers initial investment.
* Formula-2 is more appropriate since, it considers average investment instead of original investment. This can be explained as under ———



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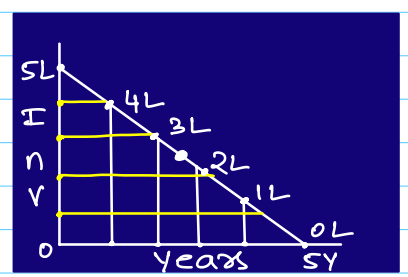
In this, we assume the same amount of original investment is used throughout the project's life.



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Here, we will consider only the revised invst value. So, under this model, we will calculate per annum investment & average it out.

↓

	Y-1	Y-2	Y-3	Y-4	Y-5
OPg	₹1,00,000	₹80,000	₹60,000	₹40,000	₹20,000
− DEP	₹ 20,000	₹20,000	₹20,000	₹20,000	₹20,000
Clg	₹ 80,000	₹60,000	₹ 40,000	₹ 20,000	₹ —
	↓	↓	↓	↓	↓
ROI	Return	Return	Return	Return	Return
	₹1,00,000	₹80,000	₹60,000	₹40,000	₹20,000

$$\text{Avg ROI\%} = \frac{\text{Avg. PAT}}{\text{Avg. invst}}$$ (derivation to 2nd formula)

* Whatever we invest on the asset is not totally exhausted. Some amount is coming back in the form of "salvage value". Salvage value is negative investment and to be reduced from the original investment while calculating the ROI%.
* While calculating average investment we will reduce the salvage. But salvage value part is actually invested. So, we will deduct for the average and add back later. WCAP is anyway expressed in p.a. terms. So no need to calc the average.

Advantages and disadvantages of ARR

Advantages	Dis-advantages
1. Uses readily available data from past records being financial info.	1. Ignores TVM
2. Evaluate the performance of operating results of an investment and management performance.	2. Depends on choice of various accounting procedures, estimates and assumptions.
3. Considers all net incomes over project lifetime.	3. Uses income from P&L a/c rather than the cash inflows.
	4. Book values are only considered. (Assets are considered at BV/WDV in the books)

(I2.) **a. Calc of ARR through original investment.**

$$ARR = \frac{\text{Average PAT}}{\text{original investment}} \times 100$$

$$= \frac{₹92,000}{₹10,00,000} \times 100$$

$$= 9.20\%$$

Under this model, salvage value is also ignored.

b. Calc of ARR through average investment

1. Average investment

$$\frac{[(\text{original invst} - \text{salvage value})]}{2} + \text{salvage value} + \text{w.cap value}$$

$$= \left[\frac{₹10,00,000 - ₹80,000}{2}\right] + ₹80,000$$

$$= ₹5,40,000$$

2. Calc of ARR

$$ARR = \frac{\text{Average PAT}}{\text{Average invst}} \times 100$$

$$= \frac{₹92,000}{₹5,40,000} \times 100$$

$$= 17.04\%$$

Example – 7:

Version 1: Annual basis

$$ARR = \frac{\text{PAT p.a.}}{\text{Investment p.a}}$$

Year	1	2	3
a. PAT	₹80,000	₹80,000	₹80,000
b. Investment	₹3,00,000	₹2,30,000	₹1,60,000
ARR (a/b)	26.67%	34.78%	50%

$$ARR\ (avg) = \frac{26.67 + 34.78 + 50}{3}$$

$$= 37.15\%$$

Version 2: Total investment basis

$$ARR = \frac{\text{Avg. PAT}}{\text{Org. investment}} \times 100$$

$$= \frac{₹\,80,000}{₹\,3,00,000} \times 100$$

$$= 26.67\%$$

Version 3: Average investment basis

$$ARR = \frac{\text{Average annual profit after tax}}{\text{Average investment}}$$

1. Average investment

[(Original investment − salvage)/2] + salvage + wcap

= [(3,00,000 − 90,000)/2] + ₹90,000 + 0

= ₹ 1,95,000.

2. ARR:-

$$\frac{₹\,80,000}{₹\,1,95,000} \times 100 = 41.02\%$$

Note: In the same question if w.cap is ₹45,000 then, ARR is as under —

Avg invst = ₹1,95,000 + ₹ 45,000 = ₹2,40,000

$$ARR = \frac{₹\,80,000}{₹\,2,40,000} \times 100 = 33.33\%$$

Pay back period

- General
- Discounted

* Pay back period means the no. of years in which the amount put into the project will be recovered.
* Pay back period will be required to be computed for 2 types of cash flows namely —
  - Annuity cash flows
  - mutiple uneven cash flows.

* Pay back period for single cash flow is its maturity period and pay back period for the perpetual CFs is same as annuity. So, we need not seperately calculate them.
* Various pay back concepts involved are as under ———
  - General pay back for annuity CF.
  - Pay back for non uniform CFs.
  - Pay back for discounted CFs.
  - Pay back reciprocal.

I. Pay back period for annuity cash flows

$$PBP = \frac{\text{Initial investment}}{\text{Annual CF (annuity)}}$$

Example-4

1. Identify initial investment = ₹ 20,00,000
2. Calculation of annual CF = ₹ 4,00,000

Particulars	Amount (₹)
PBT	₹ 3,00,000
(-) Tax @ 50%	(₹ 1,50,000)
PAT	₹ 1,50,000
(+) Depreciation	₹ 2,50,000
₹ 20,00,000 × 12.50%	
Cash flows p.a	₹ 4,00,000

3. Pay back period

$$\frac{\text{Initial investment}}{\text{Annual CFs}} = \frac{₹\,20,00,000}{₹\,4,00,000} = 5 \text{ years}$$

Example-5

II. Pay back in case of multiple uneven CFs

1. Identify intial investment = ₹ 2,00,000
2. Identification of annual CFs

yr-1	yr-2	yr-3	yr-4
₹ 80,000	₹ 60,000	₹ 60,000	₹ 20,000

3. Calculation of cumulative cash flows

year	cash flow (₹)	Cumulative CFs (₹)	Recovery
1	80,000	80,000	No
2	60,000	1,40,000	No
3	60,000	2,00,000	Yes
4	20,000		

Pay back period = 3 years

Analysis on pay back period

* Pay back period is also called as "principal pay back period". Here principal is the initial invst.
* Lower the pay back period, better will be the project.
* Pay back period v/s types of decisions

- Mutually exclusive decision
  - Project with higher PBP → Rejected
  - Project with lower PBP → Accepted
- Accept-reject decision → selection as per company's policy on PBP.

* The main defect of PBP concept is it wont consider CFs after PBP which may be in some cases are significant.

Self-made illustration

Project-A			Project-B		
yr	CF (₹ in L)		yr	CF (₹ in L)	
0	(100)	lesser PBP	0	(₹100)	Higher PBP
1	30		1	20	
2	40		2	30	
3	35		3	40	
4	10		4	60	
	✓			✗	

* Advantages and disadvantages of PBP

Advantages	Dis-advantages
1. Easy to compute.	1. Ignores TVM. All CFs are given equal weight.
2. Provides a quick estimate of time	2. Ignores CFs after PBP.
3. Easily gives risk in the project. Higher the term of PBP, more the risk involved.	3. Ignores long term projects.

III Discounted Pay back period

Discounted PBP is same as cumulative PBP except for the case that we will consider the DCF instead of CFs.

Example 10:

Cash out Lay = ₹ 30,000 , CFP.a = ₹ 6,000, PV = 15%

Year	CF(₹)	PV@15%	PVCF	Cum. PVCF	Recovery
1	6,000	0.870	5,220	5,220	No
2	6,000	0.756	4,536	9,756	No
3	6,000	0.658	3,948	13,704	No
4	6,000	0.572	3,432	17,136	No
5	6,000	0.497	2,982	20,118	No
6	6,000	0.432	2,592	22,710	No
7	6,000	0.376	2,256	24,966	No
8	6,000	0.327	1,962	26,928	No
9	6,000	0.284	1,704	28,632	No
10	6,000	0.247	1,482	30,114	Yes

Pay back period

10 years ⟶ ₹ 30,114

? ⟵ ₹ 30,000

⇒ 9.962 years.

IV Pay back reciprocal

Pay back reciprocal is exactly reverse to the PBP and PB reciprocal more like IRR i.e. Return on investment.

Example - 6

Initial investment = ₹20,000, CFp.a = ₹4,000, life = 10 years

$$\text{PB reciprocal} = \frac{\text{Annual CF}}{\text{Initial investment}}$$

$$= \frac{₹4,000}{₹20,000} \times 100$$

$$= 20\%.$$

Net Present Value (NPV concept)

* NPV is the most efficient capital budgeting technique of all.
* NPV considers all the future cash flows that are expected from a project discounted at required rate of return.
* STEPS IN NPV CALCN

Step-1 — **Identify the future expected CFs.**

If profits are given, we need to arrive at cash flows.

Step-2 — **Identity the appropriate disc. rate**

- If the project is completely financed by equity, K_e will be discount rate.
- If the project is completely financed by debt, K_d will be discount rate.
- If the project is financed by the combination of both debt and eq, use K_o as discount rate.

Step-3 — **Calculate discounted FCF**

The Future expected cash flows shall

be discounted @ required rate.

Step-4 **Identify the initial investment**

Initial investment includes ——

Initial capital outlay	=	xxx
(+) working capital	=	xxx
(−) salvage value	=	xxx

Step-5 **Calculation of NPV**

DISCI = Discounted cash inflows

DISCO = Discounted cash outflows

$$NPV = DISCI - DISCO$$

Step-6 **Decision**

SLNO	NPV	Decision
1	+ve	Accept
2	0	Indifferent
3	−ve	Reject

more analysis on NPV can be made with the help of an illustration.

(I_3) **Step-1** **Calculation of DISCI**

Amount (₹)

Year	Cash flow	PV@ 10%	PVCF
1	55,000	0.909	49,995
2	80,000	0.826	66,080
3	15,000	0.751	11,265
		DISCI =	1,27,340

Step-2 **Calculation of NPV and decision**

NPV = ΣDISCI − DISCO = ₹1,27,340 − ₹1,00,000

= ₹27,340

Since, NPV is positive, it is recommended to accept the project.

Analysis on NPV concept

* NPV represents value (in PV terms) in excess of initial investment.
* Value of any asset in PV of future CFs discounted at required rate of return.

Year	Cash flow	PV@10%	PV CF
1	55,000	0.909	49,995
2	80,000	0.826	66,080
3	15,000	0.751	11,265

DISCI = 1,27,340

Future CFs — Req. rate — Present value

Value of asset (fair)

* Therefore, the DISCI of ₹1,27,340 is nothing but fair value of asset.
* NPV is nothing but comparison between the fair value of asset and actual value of asset. Fair value is calculated as per the cost of capi-tal to the valuer (10% in this case). This can be understand as under ——

Fair value = ₹1,27,340	Fair value = ₹1,00,000	Fair value = ₹90,000
Act. value = ₹1,00,000	Act. value = ₹1,00,000	Act. value = ₹1,00,000
An asset that is worth ₹1,27,340 to the valuer is available in market @ ₹1,00,000	An asset that is worth ₹1,00,000 to valuer is available in market @ ₹1,00,000	An asset that is worth ₹90,000 to valuer is available @ ₹1,00,000
Excess benefit	Indifferent	Deficit
=	=	=
+ve NPV	0 NPV	−ve NPV
(Accept)	(may/maynot)	(Reject)

* Another interpretation of NPV

- PV factor represents return. In the given case the cost of capital is 10%. In the absence of clear information, one can assume that it is Ko (Ke & Kd not clearly given)
- It is a well accepted principle that PV factor is nothing but expected return. Risk-return relationship can be understood as under.

High risk — High return
Low risk — Low return
No risk — some return — Risk free return.

Here risk is expected cash flows and future time. The cash flows namely ₹55,000, ₹80,000 & ₹15,000 are expected cash flows and not guaranteed CFs. Yr-1 CFs are more risky than Yr-0 CFs and Yr-2 CFs are more risky than Yr-1 CFs. Therefore, return that is expected on CFs will be more for latter years than the former. This can be understood as under —

Year	PV @ 10%	
	Return	principal
1	0.091	0.909
2	0.174	0.826
3	0.249	0.751

From this it is clear that when PV factor hits a cash flow, principal portion is divided from return portion. As time pass by principal portion reduce and return increase since more the time more the risk and more the return.

Therefore, in the 1st year in ₹55,000, principal recovered is ₹49,995 and return portion is ₹5005, for 2nd year in ₹80,000, principal that is recovered is ₹66,080, return portion is ₹13,920 and for year-3, in ₹15,000, principal portion is ₹11,265 and return is ₹3,735.

The return of ₹5,005 in year 1, ₹13,920 in year 2, ₹3,735 in year 3 is return to both debt as well as equity since 10% is ko.
Hence after paying return the project has given principal recovery of ———

year	Principal
1	₹49,995
2	₹66,080
3	₹11,265
	₹1,27,340

we invested totally ₹1,00,000 principal, but the project after paying return is capable of principal recovery of ₹1,27,340. That means, after paying ₹1,00,000 principal to both debt and equity still it leaves a profit of ₹27,340 which we call as NPV.

NPV is benefit to Equity Shareholders which in turn increases share prices.

(I4.) **Step-1** **Calculation of NPV**

Amount in ₹

year	Cashflows A	Cashflows B	Cashflows C	Cashflows D	PV@12%	PVCF A	PVCF B	PVCF C	PVCF D
1	50,000	40,000	75,000	75,000	0.893	44,650	35,720	66,975	66,975
2	50,000	50,000	75,000	75,000	0.797	39,850	39,850	59,775	59,775
3	50,000	70,000	60,000	60,000	0.712	35,600	49,840	42,720	42,720
4	50,000	75,000	80,000	40,000	0.636	31,800	47,700	50,880	25,440
5	50,000	75,000	1,00,000	20,000	0.567	28,350	42,525	56,700	11,340
						1,80,250	2,15,635	2,77,050	2,06,250
(0)						(2,00,000)	(1,90,000)	(2,50,000)	(2,10,000)
NPV						−19,750	25,635	27,050	−3750
Decision						Reject	Accept	Accept	Reject

Therefore, out of ₹5,00,000 invest ₹4,40,000 in project B & C respectively @ ₹1,90,000 and ₹2,50,000.

* Advantages and disadvantages of NPV

Advantages	Dis-advantages
1. considers TVM	1. Involves difficult calculations.
2. Full cash flow stream is considered not just PBP.	2. Accuracy of NPV depends on the accuracy of estimates.
3. wealth addition can be clearly seen by SH.	3. It doesn't suit for projects of different life & size.
4. DISCI expresses everything in today's terms.	

Profitability Index (P.I)

Profitability index (PI) is just another way of expressing the NPV.

$$P.I = \frac{\Sigma DISCI}{\Sigma DISCO}$$

Situation	P.I	Decision
1	>1	Accept
2	=1	Indifferent
3	<1	Reject

* Advantages & disadvantages of PI are same as that of NPV. Hence, seperate analysis not reqd.

(I5.) **Calculation of PI for all 3 projects**

I

$$\frac{DISCI}{DISCO} = \frac{₹6,50,000}{₹5,50,000} = 1.18$$

II

$$\frac{DISCI}{DISCO} = \frac{₹95,000}{₹75,000} = 1.27$$

III

$$\frac{DISCI}{DISCO} = \frac{₹1,00,30,000}{₹1,00,20,000} = 1.01$$

Note: Though project 3 gives highest CF, its PI is very low.

Internal rate of return (IRR)

* IRR is the situation/rate at which sum of DISCI will be exactly equal to DISCO of a project.
* That means, at that rate NPV will be (0).
* NPV is calculated @ COC but IRR is the rate at which on reaches a discounted breakeven.
* Steps in calculation of IRR

I. For projects with annuity cash flows

S1: Identify initial investment.

S2: Identify the cash inflows p.a.

S3: Calculation of dummy pay back period which will be PV annuity factor

S4: Calculation of exact rate using interpol-ation.

II. For projects with multiple uneven cash flows

S1: Identify the initial investment.

S2: Identify the cash inflows over life

S3: Take a guess rate (usually given in question)

S4: Use interpolation and calculate exact rate.

(I 6) Outflow = ₹10,00,000, cash inflow p.a = ₹2,50,000.
Life = 6 years, salvage = 0

Step 1: Calculation of PBP/PVAF

At IRR, DISCI = DISCO

$\Rightarrow$ ₹2,50,000 × PVAF = ₹10,00,000

PVAF = 4

Step 2: Calculation of appropriate rate

we need calculate the rate at which annuity for 6 years should be 4 (nearing). For this, we use trail & error method in the absence of information given in the question.

@ 10% (6 years)	@ 11% (6 years)	@ 12% (6 years)	@ 13% (6 years)
4.355	4.23	4.11	3.998 ≃ 4

∴ The appropriate rate is 13% for IRR.

(I 7.)

Step 1 : Calc of NPV @ 10% PVF

Amount (₹)

Year	Cash flow	PV@ 10%	PVCF
1	30,000	0.909	27,270
2	40,000	0.826	33,040
3	60,000	0.751	45,060
4	30,000	0.683	20,490
5	20,000	0.621	12,420
		DISCI =	1,38,280
		DISCO =	(1,36,000)
		NPV =	+2,280

IRR is the rate at which ΣDISCI = DISCO but here NPV is +ve, therefore IRR is not 10%. moreover cost & value relation is inverse which means, when COC increases, value of asset will get reduced and vice versa because

$$PV(\text{asset}) = \frac{FCF}{(1+r)^n} \Rightarrow FCF \times \frac{1}{(1+r)^n}$$

↓

$(1+r)^n$ is a division and is inverse relation.

Since FVA is ₹ 1,38,280 @ rate of 10%, we need to reduce the FVA, so, need to increase rate to 11%.

Step2: Calc of NPV @ 11% PVF

Amount (₹)

Year	Cash flow	PV@ 11%	PVCF
1	30,000	0.901	27,030
2	40,000	0.812	32,480
3	60,000	0.731	43,860
4	30,000	0.659	19,770
5	20,000	0.593	11,860
		DISCI =	1,35,000
		DISCO =	(1,36,000)
		NPV =	−1,000

@ 11%, the FVA is ₹ 1,35,000 but not ₹ 1,36,000. Hence the real IRR is b/w 10% & 11%.

PV	FVA	AVA	Desired change
@10%	₹1,38,280	₹1,36,000	+₹2,280
@11%	₹1,35,000	₹1,36,000	−₹1,000
Δ = 1%	₹ 3,280		

Calc of IRR rate

From 10% POV

1% → ₹3,280

? ← ₹2,280

+0.695%

10 + 0.695

= 10.695%

From 11% POV

1% → ₹3,280

? ← −₹1,000

−0.305%

11 − 0.305

= 10.695%

(I8.)

Step 1: Calculation of CFp.a.

Particulars	Amount (₹)
EBIT	68,000
(−) Tax @ 45%	(30,600)
EAT	37,400
(+) Depreciation ₹3,60,000/5	72,000
Cash inflow p.a.	1,09,400

Step 2: Calculation of dummy rate

At IRR DISC1 = DISCO

∴ ₹1,09,400 × PVAF = ₹3,60,000

$$PVAF = \frac{₹3,60,000}{₹1,09,400}$$

= 3.29.

Step3: Calculation of exact rate

The PV annuity factor has come to 3·29. As per the information given in the question, it stands between 15% & 16%.

FVA (@ both rates)

@15%	@16%
₹ 1,09,400 × 3·35	₹ 1,09,400 × 3·27
= ₹ 3,66,490	= ₹ 3,57,738

	PV	FVA	AVA	Desired change
	@15%	₹ 3,66,490	₹ 3,60,000	+ ₹ 6,490
	@16%	₹ 3,57,738	₹ 3,60,000	− ₹ 2,262
Δ =	1%	₹ 8,752		

Calc of IRR rate

From 15% POV	From 16% POV
1% ⟶ ₹ 8,752	1% ⟶ ₹ 8,752
? ⟵ ₹ 6,490	? ⟵ −₹ 2,262
+ 0·742%	− 0·258%
15 + 0·742	16 − 0·258
= 15·742%	= 15·742%

Alternatively (ICAI)

	PV	PVAF	Desired PVAF	Change
	@15%	3·35	3·29	+0·06
	@16%	3·27	3·29	−0·02
Δ =	1%	0·08		

15% POV: 1% ⟶ 0·08
? ⟵ 0·06
= +0·75 ⇒ 15·75

16% POV: 1% ⟶ 0·08
? ⟵ −0·02
= −0·25 ⇒ 15·75%

* Advantages and disadvantages of IRR

Advantages	Dis-advantages
1. Uses TVM	1. Process is tedious and time consuming
2. Full cash-flows are taken not just upto pay back.	2. cannot be used for the projects with different CFs.
3. Easy to use	3. Ignores re-investment at cost of capital.
4. Helps in wealth maxn.	
5. will help to know the break even rate.	

Concept of Capital Rationing

* Ration represents usage of limited resources to distribute to various persons.
* capital rationing (CR) is a situation wherein the company has no. of. good projects to accept but could not accept all due to constraint in capital.
* In such case, within the available capital best projects should be selected so that, NPV is maximised.
* To earn increased NPV, we should not rank the projects on the basis of their NPV but should rank on basis of P.I.
* The above point is explained through following example ————

capital available = ₹100crs

Particulars	A	B	C
Outlay	(100)	(50)	(50)
DISCI	150	80	80
NPV	50	30	30
Ranking @ NPV	I	II	II ✗
PI	1.50	1.60	1.60
Ranking @ PI	II	I	I ✓

* All the 3 projects are good but we cannot do all due to fund constraint. we have only ₹100 crores but all of them require ₹200crs. If we allocate based on NPV ranking the ₹100crs we can do only project A earning the NPV of ₹50cr. But, if we allocate based on PI, we can do projects B&C, earning ₹60crs NPV Thus, PI should be used for ranking in case of capital rationing.

* CR is done under 2 situations

Divisible projects	Indivisible projects
partial acceptance of project is possible earning proportionate NPV	Either accept in full (or) reject.

* The above is explained through the following example:

capital available = ₹150 crs

Particulars	A	B	C
Outlay	(100)	(50)	(50)
DISC1	150	80	80
NPV	50	30	30

situation-1 : Divisible projects (₹ in crs)

Project	Investment	prop	NPV	NPV × prop
B	₹50	100%	₹30	₹30
C	₹50	100%	₹30	₹30
A	₹50	50%	₹50	₹25
				₹85

Situation – 2 : Indivisible projects (₹ in crores)

Combination	NPV
B + C	₹30 + ₹30 = ₹60 ✗
A + B	₹50 + ₹30 = ₹80 ✓ (or)
A + C	₹50 + ₹30 = ₹80 ✓

(I 13.)

Step 1: Ranking the projects by P.I.

Project	DISC0	NPV	DISC1	P.I	Rank
A	(50,000)	15,400	65,400	1.31	V
B	(40,000)	18,700	58,700	1.47	II
C	(25,000)	10,100	35,100	1.40	III
D	(30,000)	11,200	41,200	1.37	IV
E	(35,000)	19,300	54,300	1.55	I

Step 2: Selection (For divisible projects)

Project	Total Cap	Req. Cap	Bal. Cap	NPV
E	₹1,20,000	₹35,000	₹85,000	₹19,300
B	₹85,000	₹40,000	₹45,000	₹18,700
C	₹45,000	₹25,000	₹20,000	₹10,100
D	₹20,000	₹20,000 ⊛	–	₹7,467 (₹11,200 × 2/3)
A	–	–	–	–
				₹55,567

⊛ project D capital requirement is ₹30,000, but fund available is only ₹20,000. So, we can proportionately consider 2/3rd project D only.

Step 3: Selection if projects are indivisible

Combination	Capital	NPV	Ranking
E + B + C	₹1,00,000	₹48,100	II
E + B + D	₹1,05,000	₹49,200	I

Select projects E, B & D if projects are indivisible.

NPV and IRR conflicts – Disparities

Concept 1 – Disparity 1 – Timing / size disparity.

Let us consider an example to understand this concept.

Particulars	Project X	Project Y
Initial outlay	₹ 1,10,000	₹ 1,10,000
Inflows		
Year 1	₹ 31,000	₹ 71,000
Year 2	₹ 40,000	₹ 40,000
Year 3	₹ 50,000	₹ 40,000
Year 4	₹ 70,000	₹ 20,000

Calculate the NPV and IRR with an assumption that

Case 1 : Re-investment rate is 14%

Case 2: Re-investment rate is 20%

In both cases cost of capital is 10%.

Stage-1 Analysis

Step 1: Calculation of NPV

Year	CF – X	CF – Y	PV @ 10%	PVCF – X	PVCF – Y
1	31,000	71,000	0.9091	28,182	64,546
2	40,000	40,000	0.8264	33,056	33,056
3	50,000	40,000	0.7513	37,565	30,052
4	70,000	20,000	0.6830	47,810	13,660
Total (DISCI)				1,46,613	1,41,314
(–) Total (DISCO)				(1,10,000)	(1,10,000)
NPV				36,613	31,314

Step 2: Calculation of IRR

For proj X

Year	CF	PV @ 20%	PVCF	PV @ 24%	PVCF
1	31,000	0.833	25,823	0.806	24,986
2	40,000	0.694	27,760	0.650	26,000
3	50,000	0.579	28,950	0.524	26,200
4	70,000	0.482	33,740	0.423	29,610
			1,16,273		1,06,796

PV	FVA	Desired value	Change
@ 20%	₹ 1,16,273	₹ 1,10,000	+6,273
@ 24%	₹ 1,06,796	₹ 1,10,000	−3,204
Δ = 4%	₹9,477		

4% ⟶ 9,477

20% POV ? ⟵ +6,273

⇒ +2.64

↓

22.65%

4% ⟶ 9477

24% POV ? ⟵ −3204

⇒ −1.35

↓

22.65%

For understanding sake, lets assume 22% as IRR rate.

For proj Y

year	CF	PV@24%	PVCF	PV@28%	PVCF
1	₹71,000	0.806	57,226	0.781	55,451
2	₹40,000	0.650	26,000	0.610	24,400
3	₹40,000	0.524	20,960	0.477	19,080
4	₹20,000	0.423	8,460	0.373	7,460
			1,12,646		1,06,391

PV	FVA	Desired value	Change
@ 24%	₹ 1,12,646	₹ 1,10,000	+2,646
@ 28%	₹ 1,06,391	₹ 1,10,000	−3,609
Δ = 4%	₹6,255		

4% ⟶ ₹6,255

24% POV ? ⟵ +2,646

⇒ +1.69%

↓

25.69%

4% ⟶ ₹6,255

28% POV ? ⟵ −3,609

⇒ −2.30%

↓

25.7%

For understanding sake, lets assume 26% as IRR rate.

Summary

	Proj X	Proj Y
NPV	+₹36,613	₹31,314
IRR	22%	26%

conclusion – 1

In the above table it could be seen that NPV selects 'x' while IRR selects 'y'.

Reason for the conflict is re-investment rate assumptions of NPV and IRR.

NPV assumes the intermediary funds of project to be re-invested at cost of capital rate. while IRR assumes re-investment @ IRR rate.

Stage 2 analysis

1. meaning of terms used

a. Intermediary funds : The cashflow every year a project give over its life.

b. Re-investment rate : Rate at which intermediary funds are re-invested.

c. cost of capital : cost of capital used in project

d. IRR rate : Rate at which NPV is "0".

2. Proof that NPV assumes COC as RI rate

'proj x'

Year	CF	No. of years invested	Calculation $FV = PV(1+r)^n$	Amount (₹) (FV)
1	31,000	3	$31,000(1.10)^3$	41,261
2	40,000	2	$40,000(1.10)^2$	48,400
3	50,000	1	$50,000(1.10)^1$	55,000
4	70,000	0	$70,000(1.10)^0$	70,000
			Total =	₹2,14,661

let us assume a scenario where a company invested in this project promptly re-invested intermediary funds @ COC i.e. 10%, after 4 yrs it will end up having ₹2,14,661.

Year	CF	PV @ 10%	PVCF
0	(₹1,10,000)	1	(₹1,10,000)
4	₹ 2,14,661	0.683	₹1,46,613
		NPV	₹ 36,613

Conclusion-2 :-

* From the overall project POV if one see it, there is no cash inflow in hand @ end of 1st year since it is re-invested back for next 3 years. That means the amount of ₹ 1,10,000 is invested and intermediary cash inflows are being re-invested and on-hand cash comes out only at the end of 4th year.
* If we calculate NPV on overall basis, then also NPV stands at same ₹ 36,613. That means, it is clear that, NPV of ₹ 36,613 will come if and only if intermediary funds are reinvested @ COC.

Stage 3 Analysis

How re-investment rate affects project selection?

a. Observation of 2 projects gives us following results –

Total cash inflow	X : ₹ 1,91,000	Y : ₹ 1,71,000
Timing	X : Big CFs comes later	Y : Big CFs comes earlier.

b. Suppose, we assume a re-investment rate as low as 0%, in this case, project X will be preferred since the project gives us highest CF in hand at end of 4 years. In another extreme case, say an interest of 100%, we would like to go for project Y since it gives heavy CFs earlier and giving a chance to earn high interest.

c. NPV assumes re-investment rate as COC which is very low and hence it selects project X. whereas IRR which is very high selects project Y.

Stage 4 Analysis

Reason for conflict

* NPV assumes re-investment @ COC whereas IRR assumes re-investment @ IRR rate.
* Out of the 2, NPV is sound principle because,

it assumes that same COC rate to be the rate of re-investment where as IRR makes an absurd assumption of re-investing at higher rates.

* IRR is considered as inferior to NPV because, re-investment rate will be different for 2 different projects. It is not a sane assumption to make that project X CFs are reinvested @22%. when there is place to re-invest @ 26%.

Stage 5 Analysis

How to resolve the conflict?

* As we have found out that conflict is due to re-inust rate difference b/w NPV and IRR, we should then settle for a common re-investment rate.

* Can that Re-investment rate be COC?
  It can be if there is no better investment opp. But it will not be if we have better investment opp. If we can re-invest @ 14%, why should we repay capital and save 10%?

* Can it be IRR rate?
  a. IRR is an impracticable rate for re-investment. One cannot expect market to give such an exorbitant rates.
  b. If we go for IRR rate, the re-investment rate is different for different projects which is absurd. This is because CFs from any project will fetch same interest.

* Then, what should be the re-investment rate?
  It is the rate at which we can realistically re-invest.

Stage 6 analysis

Project X

Year	CF	No. of years invested	Calculation $FV = PV(1+r)^n$	Amount (₹) (FV)
1	31,000	3	$31,000(1.14)^3$	45,927
2	40,000	2	$40,000(1.14)^2$	51,984
3	50,000	1	$50,000(1.14)^1$	57,000
4	70,000	0	$70,000(1.14)^0$	70,000
			Total =	₹2,24,911

Year	CF	PV @ 10%	PVCF
0	(₹1,10,000)	1	(₹1,10,000)
4	₹2,24,911	0.683	₹1,53,614
		modified NPV =	₹ 43,614

Modified IRR

Year	CF
0	(₹1,10,000)
4	₹2,24,911

$FV = PV(1+r)^n$

₹2,24,911 = ₹1,10,000$(1+r)^4$

$(1+r)^4 = 2.0446$

$1+r = \sqrt[4]{2.0446}$; $1+r = 1.1958$

$r = 19.58\%$

Project Y

Year	CF	No. of years re-invested	Calculation $FV = PV(1+r)^n$	Amount (₹) (FV)
1	₹1,000	3	₹1,000 $(1.14)^3$	1,05,187
2	40,000	2	40,000 $(1.14)^2$	51,984
3	40,000	1	40,000 $(1.14)^1$	45,600
4	20,000	0	20,000 $(1.14)^0$	20,000
			Total =	₹2,22,771

Year	CF	PV @ 10%	PVCF
0	(₹1,10,000)	1	(₹1,10,000)
4	₹2,22,771	0.683	₹1,52,153
		modified NPV =	₹ 42,153

Modified IRR

Year	CF
0	(₹1,10,000)
4	₹2,22,771

$FV = PV(1+r)^n$

₹2,22,771 = ₹1,10,000$(1+r)^4$

$(1+r)^4 = 2.025$; $1+r = \sqrt[4]{2.025}$

$1+r = 1.1929$; $r = 19.29\%$

Final conclusion

Particulars	Project X	Project Y
Modified NPV	₹43,614	₹42,153
Modified IRR	19.58%	19.29%

Under both models, project 'X' only will be selected since conflict is resolved.

Concept 2 – Disparity 2 – Life disparity

1. Both NPV and IRR measures the profitability of the project.
2. NPV measures in value, whereas IRR measures as a % rate.
3. In case of accept-reject decisions, if IRR > ko, NPV will be positive and both the techniques recommends accept and vice versa.
4. However, in case of mutually exclusive decision, NPV may select project A and IRR may be on project B. This situation is called as "NPV – IRR conflict".
5. NPV – IRR conflict will arise due to the following 2 situations

- Life disparity
- Timing disparity → Already discussed.

Concept of Life disparity

* NPV sees the quantum of return, while IRR sees the speed (or) rate of return.
* Longer the project, more the quantum, more the NPV.
* Faster the cash flows, more the IRR.
* If project A has longer life and project B has faster CFs, NPV selects project A and IRR selects project B. Hence, conflict arises.
* It is wrong to compare NPV of project with another project with inequal life. We should not compare a project having say, 3 years life with another project with say 2 years life.

* The right way is to make the projects into equal life and then compare. This can be done 2 ways

Repetition method	EAB / EAC
Perform 3 years project 2 times and 2 year project 3 times make it into 6 yrs CF and then compare NPV.	calculate NPV on p.a. basis and then we compare.

* NPV p.a is what we refer as EAB (Equated annuity benefit).

$$EAB = \frac{NPV}{\text{annuity factor}}$$

* If it is outflow dominated question, we will go for EAC.

The above theory, can be practically taken as under ——

	project - A	project - B
outflow	(₹ 50)	(₹ 50)
In flow		PV@10%
year-1	₹ 30	₹90
year-2	₹ 90	–

In this example, one cannot compare the project A & B directly because, project A is a 2 years project and project B is a 1 year project. So, the projects are having unequal lives. Therefore, it resulted in timing disparity. Before resolving this conflict / disparity, we need to first understand existing NPV & IRR.

	proj. A	proj. B
NPV	[(₹30×0.909)+(₹90×0.826)] − ₹50	[(₹90×0.909)] − ₹50
	= ₹101.61 − ₹50 = ₹ 51.61	= ₹81.81 − ₹50 = ₹31.81

IRR	Low (Due to lower recovery)	High (Due to higher recovery)

In this case NPV favours project A and IRR favours project 1. This is due to unequal lives and can be resolved using 2 approaches

Approach - 1 Repetition method

Under this method, both are compared by bringing CFs to equivalent stage. In the given case, project X is 2 years life and project Y is of 1 year life, to compare on evenly basis, project X should be carried out 1 time (2yrs) and project Y should be carried out 2 times (1yr x 2 = 2yrs). The result is as follows ——

Project X (₹)

yr	CF	PV@10%	PVCF
0	(50)	1	(50)
1	30	0.909	27.27
2	90	0.826	74.34

NPV = ₹51.61

Project Y (₹)

yr	CF	PV@10%	PVCF
	Cycle - 1		
0	(50)	1	(50)
1	90	0.909	81.81
	Cycle - 2		
1	(50)	0.909	(45.45)
2	90	0.826	74.34

NPV = ₹60.70

∴ It is clear that project Y is recommended.

Approach - 2 Equate annuity benefit model

This model is just opposite to the previous model where any project of any life is then expressed in per annum terms.

$$\downarrow$$

$$\frac{NPV}{PVAF}$$

projects

X	Y
NPV = ₹51.61	NPV = ₹31.81
PVAF = $\frac{1}{1.736}$	↓
EAB = ₹29.73	This is already in 1 year terms.

Since EAB of project Y is higher, it is to be accepted.

Notes

Though it can be done 2 ways namely the repetition model and EAB model, EAB model is most recommended since repetition model is not practical. This can be understood as under ——

	project X	project Y	Action to be taken
Life	2 years	1 year	* carry X 1 time * carry Y 2 times
Life	4 years	3 years	* carry X 3 times * carry Y 4 times
Life	9 years	11 years	* carry X 11 times * carry Y 9 times

When life of projects are very big like in the 3rd case in above example, the project should be repeated for 99 times and hence one need to analyse 99 years cashflows which is eventually impracticable. Hence, EAB model is best fit for projects with unequal lives.

All illustrations from ISM w.r.t. disparities.

(Eg.) **Step 1: Calculation of Future value CFs.**

Year	CF(₹)	No. of years invested	Calculation $FV = PV(1+r)^n$	Amount(₹) (FV)
1	30,000	4	$30,000(1.08)^4$	40,815
2	40,000	3	$40,000(1.08)^3$	50,388
3	60,000	2	$60,000(1.08)^2$	69,984
4	30,000	1	$30,000(1.08)^1$	32,400
5	20,000	0	$20,000(1.08)^0$	20,000
			Total Value	= 2,13,587

Step 2: Calculation of MIRR.

Summary CFs

yr	CF
0	(₹1,36,000)
5	₹ 2,13,587

$FV = PV(1+r)^n$

₹ 2,13,587 = ₹ 1,36,000 $(1+r)^5$

$(1+r)^5 = 1.5705$

$1+r = \sqrt[5]{1.5705}$

$1+r = 1.0945$

$r = 0.0945$ (or) 9.45%

Analysis :-

The realised return is 9.45%, where as ko is 8%. Since realised ROR is more than the cost of capital, one can understand that NPV of the project @ 8% ko is surely positive.

Notes

It should be noted that question lacks clarity in giving reinvestment rate, therefore going by NPV logic, it is assumed that, intermediary funds are reinvested @ COC.

(I10.) **Tips**

In the given question, there are 2 projects namely project A and project B. Both the projects will need different cash outflows. The size of both the projects is different. Project A is a small sized project and project B is a heavy project (in terms of capital). Hence, ranking the project by normal NPV and IRR may end up giving an absurd result. Therefore, one must go by modified NPV and modified IRR concepts. However, to calc MNPV (or) MIRR, we need to have a reinvestment rate. But, no such rate is provided in the question given. Hence, we should calculate NPV and IRR and then should conclude that there is a disparity and it is called as timing/size/cash flow disparity.

Step 1: Calculation of NPV of projects A & B

(Amt in ₹)

Year	CF-A	CF-B	PV @ 10%	PVCF-A	PVCF-B
1	50,000	1,40,000	0.909	45,450	1,27,260
2	60,000	1,90,000	0.826	49,560	1,56,940
3	40,000	1,00,000	0.751	30,040	75,100
Total (DISCI)				1,25,050	3,59,300
(-) Total (DISCO)				(1,00,000)	(3,00,000)
NPV				+ 25,050	+ 59,300

Step 2: Calculation of IRR on Project A

Year	CF (₹)	PV @ 22%	PV @ 25%	PVCF (22%)	PVCF (25%)
1	50,000	0.820	0.800	41,000	40,000
2	60,000	0.672	0.640	40,320	38,400
3	40,000	0.551	0.512	22,040	20,480
			Total =	1,03,360	98,880

PV	FVA	Desired value	Change
@ 22%	₹ 1,03,360	₹ 1,00,000	+ ₹ 3,360
@ 25%	₹ 98,880	₹ 1,00,000	− ₹ 1,120
Δ = 3%	₹ 4,480		

22% POV

3% ⟶ ₹ 4,480
? ⟵ + 3,360
⇒ +2.25%
↓
24.25 %

25% POV

3% ⟶ ₹4,480
? ⟵ − 1,120
⇒ − 0.75%
↓
24.25 %

Step 2: Calculation of IRR on Project B

Year	CF (₹)	PV @ 20%	PV @ 25%	PVCF (20%)	PVCF (25%)
1	1,40,000	0.833	0.800	1,16,620	1,12,000
2	1,90,000	0.694	0.640	1,31,860	1,21,600
3	1,00,000	0.579	0.512	57,900	51,200
			Total =	3,06,380	2,84,800

	PV	FVA	Desired value	Change
@ 20%	₹ 3,06,380		₹ 3,00,000	+ ₹ 6,380
@ 25%	₹ 2,84,800		₹ 3,00,000	− ₹ 15,200
Δ = 5%		₹ 21,580		

20% POV

5 % ⟶ ₹21,580
? ⟵ + 6,380
⇒ + 1.48%
↓
21.48 %

25% POV

5 % ⟶ ₹21,580
? ⟵ − 15,200
⇒ − 3.52%
↓
21.48 %

Step 3: Final result

	Project A	Project B
NPV	₹ 25,050	₹ 59,300
IRR	24.25%	21.48%

NPV favours proj B and IRR favours proj A.
There exists a conflict due to timing disparity.

(II)

Tips

* In the given question, there are 2 projects namely —
  Project X: Project with lower overall cash flow but bigger initial cash inflows.
  Project Y: Project with higher overall cash flow but smaller initial cash inflows.
* Since project X has lower overall cash inflow NPV doesn't favour it but due higher speedy recovery, IRR will surely favour the project.
* Since project Y has higher overall cash inflow NPV will surely favour, but due to slow mode of recovery, IRR doesn't favour the project.
* Hence, the summary is, NPV favours Project Y and IRR favours project X.

Step 1: Calculation of NPV of project X & Y

(Amt in ₹)

Year	CF-X	CF-Y	PV@10%	PVCF-X	PVCF-Y
1	2,00,000	50,000	0.909	1,81,800	45,450
2	1,00,000	1,00,000	0.826	82,600	82,600
3	50,000	3,00,000	0.751	37,550	2,25,300
Total (DISC)				3,01,950	3,53,350
(-) Total (DISCO)				(2,50,000)	(3,00,000)
NPV				+ 51,950	+ 53,350

Step 2: Calculation of IRR on Project X

Year	CF (₹)	PV@20%	PV@25%	PVCF(20%)	PVCF(25%)
1	2,00,000	0.833	0.800	1,66,600	1,60,000
2	1,00,000	0.694	0.640	69,400	64,000
3	50,000	0.579	0.512	28,950	25,600
			Total =	2,64,950	2,49,600

PV	FVA	Desired value	Change
@20%	₹2,64,950	₹2,50,000	+14,950
@25%	₹2,49,600	₹2,50,000	− 400.
Δ = 5%	₹15,350		

20% POV

5% ⟶ ₹15,350

? ⟵ +14,950

⇒ +4.87%

↓

24.87%

25% POV

5% ⟶ ₹15,350

? ⟵ − 400

⇒ −0.13%

↓

24.87%

Step 3: Calculation of IRR of project Y.

Year	CF (₹)	PV @ 16%	PV @ 18%	PVCF (16%)	PVCF (18%)
1	50,000	0.862	0.847	43,100	42,350
2	1,00,000	0.743	0.718	74,300	71,800
3	3,00,000	0.641	0.609	1,92,300	1,82,700
			Total =	3,09,700	2,96,850

PV	FVA	Desired value	Change
@ 16%	₹3,09,700	₹3,00,000	+₹9,700
@ 18%	₹2,96,850	₹3,00,000	−₹3,150
Δ = 2%	₹12,850		

16% POV

2% ⟶ ₹12,850

? ⟵ +₹9,700

⇒ +1.51

↓

= 17.51%

18% POV

2% ⟶ ₹12,850

? ⟵ −₹3,150

⇒ −0.49%

↓

= 17.51%

Step 3: Final result

	Project X	Project Y
NPV	₹51,950	₹53,350
IRR	24.87%	17.51%

NPV favours project Y and IRR favours proj X. Therefore, there is a timing disparity.

(I12)

Step 1: Calculation of NPV of projects A & B

(Amt in ₹)

Year	CF – A	CF – B	PV @ 12%	PVCF – A	PVCF – B
1	7,50,000	2,00,000	0.893	6,69,750	1,78,600
2	0	2,00,000	0.797	0	1,59,400
3	0	7,00,000	0.712	0	4,98,400
Total (DISCI)				6,69,750	8,36,400
(–) Total (DISCO)				(5,00,000)	(5,00,000)
NPV				1,69,750	3,36,400

Step 2: Calculation of IRR of project A

Year	CF (₹)	PV @ 45%	PV @ 55%	PVCF (45%)	PVCF (55%)
1	7,50,000	0.690	0.645	5,17,500	4,83,750
2	0	0.476	0.416	0	0
3	0	0.328	0.269	0	0
			Total =	5,17,500	4,83,750

	PV	FVA	Desired value	Change
@	45%	₹5,17,500	₹5,00,000	+₹17,500
@	55%	₹4,83,750	₹5,00,000	–₹16,250
Δ =	10%	₹ 33,750		

POV

10% ⟶ ₹33,750

? ⟵ +₹17,500

⇒ + 5.19

= 50.19%

POV

10% ⟶ ₹33,750

? ⟵ –₹16,250

⇒ – 4.81

= 50.91%

appx 50%

Step 2: Calculation of IRR of project B

Year	CF (₹)	PV @ 40%	PV @ 45%	PVCF (40%)	PVCF (45%)
1	₹2,00,000	0.714	0.690	1,42,800	1,38,000
2	₹2,00,000	0.510	0.476	1,02,000	95,200
3	₹7,00,000	0.364	0.328	2,73,000	2,46,000
			Total =	5,17,800	4,79,200

	PV	FVA	Desired value	Change
@	40%	₹5,17,800	₹5,00,000	+ ₹17,800
@	45%	₹4,79,200	₹5,00,000	− ₹20,800
Δ =	5%	₹38,600		

40% POV

5% ⟶ ₹38,600

? ⟵ +₹17,800

+ 2·31 %

= 42·31%

45% POV

5% ⟶ ₹38,600

? ⟵ −₹20,800

⇒ − 2·69%

= 42·31%.

Step3: Final result

	Project A	Project B
NPV	₹1,69,750	₹3,36,400
IRR	50%	42·31%

NPV favours project B and IRR favours proj A. Therefore, there is a timing disparity and also life disparity.

(Q.14) Analysis:

In the given question, there are 2 projects namely

Project A – Life of 6 years and

Project B – Life of 3 years

Since, both the projects are having unequal lives, we cannot consider NPV directly rather we need to consider equated annuity benefit.

$$EAB = \frac{NPV (₹)}{PVAF}$$

Particulars	Project A	Project B
NPV (₹)	₹6,49,094	₹5,15,488
PVAF	4·111	2·402
EAB (₹)	₹1,57,892	₹2,14,608

Since EAB is more for project B, it is recommend-ed from NPV point of view.

Always NPV is superior to IRR, therefore IRR shall be ignored.

(I 15.)

Step 1: Calculation of pay back period

$$\text{Pay back period} = \frac{\text{Total out flow}}{\text{Annual Cash inflow}}$$

Particulars	Proj – A	Proj – B	Proj – C	Proj – D
PBP	1 year	1.33 years	2.33 yrs	1 year
	₹10,000	yr CF	yr CF	yr CF
	₹10,000	1 ₹7,500	1 ₹2,000	1 ₹10,000
		2 ₹7,500	2 ₹4,000	2 –
		↓	3 ₹12,000	3 –
		$1yr + \left[\frac{2,500}{7,500}\right]$	$2yr + \left[\frac{4,000}{12,000}\right]$	

Step 2: Calculation of ARR.

Alt – 1

$$\text{Average rate of return} = \frac{\text{Avg PAT}}{\text{Org Invst}}$$

Particulars	Proj – A	Proj – B	Proj – C	Proj – D
a. Avg PAT	₹10,000	₹7,500	₹6,000	₹5,333
b. Org Invst	₹10,000	₹10,000	₹10,000	₹10,000
c. ARR under org. invst (a/b)	100%	75%	60%	53.33%

Alt – 2
As per ICAI

I. For project – A

a. Average PAT

Given amounts are CFs. CF = PAT + Dep. That means PAT = CF – Depn.

PAT = ₹10,000 – ₹10,000 = ₹0

Note: Since, method of depreciation is not given we assumed SLM basis and under SLM, complete value of asset will be depreciated over its life. Hence, cost = Depreciation.

b. Average investment

$$\text{Avg. invst} = \frac{\text{op. inv} + \text{Cl. invt} - \text{SV}}{2} + \text{SV} + \text{WCap}$$

$$= \frac{₹10,000 + 0 - 0}{2} + 0 + 0 = ₹5,000$$

Note: since, investment value is same across all the projects, avg. invst will ₹ 5,000 in all cases.

c. ARR calc

$$\frac{\text{Avg. PAT}}{\text{Avg. invst}} \times 100 = \frac{₹0}{₹5,000} \times 100 = 0\%.$$

II. For project – B

a. Avg PAT

$$\frac{\text{Total CF} - \text{Depn (cost of asset)}}{2}$$

$$= \frac{₹15,000 - ₹10,000}{2}$$

$$= ₹2,500.$$

b. ARR

$$\frac{₹2,500}{₹5,000} \times 100 = 50\%$$

III. For project C

a. PAT (avg) = TCF − D

$$= \frac{₹18,000 - ₹10,000}{3}$$

$$= ₹2,667.$$

b. ARR

$$\frac{₹2,667}{₹5,000} \times 100 = 53.33\%$$

IV. For project D

a. PAT (avg) = TCF − D

$$= \frac{₹16,000 - ₹10,000}{3} = ₹2,000$$

b. ARR $= \frac{₹2,000}{₹5,000} \times 100 = 40\%$

FINANCING COST IRRELAVANCE

Total fund approach V/S Equity shareholders approach

* Any project requires investment which is generally financed by debt and equity.
* The status of debt holder is the subject matter of discussion in these 2 approaches.
* Analysis

Total funds / project approach	Equity shareholder's approach
1. Here both debt & equity are considered as the owners of the project.	1. Here only equity share holder are considered as owners and debt is considered as "outsider".
2. Here, we need to consider entire outlay of the project	2. Here, we need to consider only that part which is financed by ESH.
3. Interest and principal repayments should not be treated as outflows. since, they are paid to owners and not outsiders.	3. These should be treated as outflows because, they are paid to the outsiders.
4. This model uses the over all cost of capital (K_0) for discounting	4. This model uses the cost of equity (K_e) for discounting.

Yr	CF	
0	(150)	→ Debt (₹100cr) / → Equity (₹50cr)
1–10	₹ 40cr	

Yr	CF	
0	(150)	→ Debt (₹100cr) / → Equity (₹50cr)
1–10	₹ 40cr	

consolidated picture

Yr	CF
0	(₹ 150cr)
1-10	₹ 40cr

Use k_0 for the purpose of discounting the cash flows

consolidated picture

Yr	CF
0	(₹ 50cr)
1-10	₹ 40cr - Interest - Installment

Use k_e for the purpose of discounting the cash flows.

Indepth analysis using an illustration.

Particulars	Amt (₹ in 000's)
Sales	400
Cost	(270)
EBIT	130
Interest	(30)
EBT	100
Tax	(40)
EAT	60

Find out cash flow for investing decision.

Solution

I	₹	II	₹
EBIT	1,30,000	EBIT	1,30,000
(−) Interest	(30,000)	(−) Interest	(30,000)
EBT	1,00,000	EBT	1,00,000
(−) Tax @ 40%	(40,000)	(−) Tax @ 40%	(40,000)
EAT	60,000	EAT	60,000
(+) Interest	30,000	(+) Interest	18,000 ⊛
	90,000 X		78,000

₹30,000 (1 − 0.40)
= ₹18,000.

Notes:

1. In Long term funds approach, interest is not an outflow but an appropriation.
2. In PAT of ₹60,000 that interest is reduced wrongly as an outflow. Hence, add it back.
3. When we add back interest, donot add the entire interest, add only I (1−t).
4. Why should we add only I (1−t)?

   * If interest is ignored since it is a finance cash flow to owner only, the tax shield on interest also should be ignored because it is also coming from the way of financing and not from the investment.

   $+I - I \times t \Rightarrow +I(1-t)$

5. Tax shield on interest is really enjoyed then why that benefit is ignored?

This is considered while calculating WACC.

6. In the above example, the project gives every year to its fund providers ₹78,000. when we discount this using WACC which consists of ke and Kd (post-tax), then, we have already consi-dered the expected dividends, interest payments and the tax shield. The balance left is discounted cash inflow which is the amount available to repay the principal (cost of project). If this is more, the entire surplus is enjoyed by ESH which is called NPV which increases the share price.

Illustrating impact of discounting

year	CF (₹)	PV @ 16% (Ko)	PVCF (₹)
1	1,00,000	0.862	86,200
2	3,00,000	0.743	2,22,900
3	1,50,000	0.641	96,150
		DISCI	4,05,250
		DISCO	(3,00,000)
		NPV (+ve)	1,05,250.

year – 1

₹1,00,000

Financing costs — Principal repayment

Interest costs — Dividing costs

Already considered in WACC/Ko.

Practical Problems

(Q1:) **missing information calculation**

(i:) **Cost of Project**

Given IRR as 12%. At IRR, sum of disc CFs will be exactly equal to DISCO. DISCO is nothing but cost of the project.

At IRR DISCI = DISCO

Year	CF (₹)	PV@12%	PVCF (₹)
1 – 4	1,00,000	3.037	₹ 3,03,700

since DISCI = DISCO, cost of project is ₹3,03,700.

(ii:) **Net Present value**

Given, P.I as 1.064. That means, the given project is a positive NPV project.

$$P.I = \frac{DISCI}{DISCO} = 1.064$$

$$\Rightarrow \frac{DISCI}{₹3,03,700} = 1.064$$

$$DISCI = ₹3,23,137$$

NPV = DISCI − DISCO

= ₹3,23,137 − ₹ 3,03,700

= + ₹ 19,437.

(iii:) **Pay back period** (without discounting)

$$\frac{\text{Initial investment}}{\text{Annual CF}} = \frac{₹3,03,700}{₹1,00,000}$$

= 3.037 years.

(iv:) **Cost of Capital (Ko)**

DISCI (%, 4Y) = ₹ 3,23,137

DISCI = CFp.a X PVAF

(Annuity CF)

₹ 3,23,137 = ₹1,00,000 X PVAF

PVAF = 3.231

As per given table, 3.231 approximates at 9%

∴ Cost of Capital (Ko) is 9%.

(Q3) Step1: Calc of NPV @ 15%

Year	CF (₹)	PV @ 15%	PVCF
0	(7,00,000)	1	(7,00,000)
1	(10,00,000)	0.870	(8,70,000)
2	2,50,000	0.756	1,89,000
3	3,00,000	0.658	1,97,400
4	3,50,000	0.572	2,00,200
5-10	4,00,000	2.164	8,65,600
		NPV	−₹1,17,800

Step2: Calc of NPV @ 10%

Year	CF (₹)	PV @ 10%	PVCF
0	(7,00,000)	1	(7,00,000)
1	(10,00,000)	0.909	(9,09,000)
2	2,50,000	0.826	2,06,500
3	3,00,000	0.751	2,25,300
4	3,50,000	0.683	2,39,050
5-10	4,00,000	2.975	11,90,000
		NPV	+₹2,51,850

Step3: Calc of IRR

IRR is a place where DISCI = DISCO. In the given question, if PV is 10%, the NPV is ₹2,51,850 positive. On the other hand, if PV is 15%, the NPV is −₹1,17,800. Therefore, IRR is somewhere between 10% & 15%.

PV	NPV (Actual)	NPV (Desired)	Change
@10%	+₹2,51,850	0	+₹2,51,850
@15%	−₹1,17,800	0	−₹1,17,800
5%	₹3,69,650		

IRR

From 10% POV

5% ⟶ ₹3,69,650

? ⟵ ₹2,51,850

⇒ +3.41%

IRR = 10 + 3.41 = 13.41%

From 15% POV

5% ⟶ ₹3,69,650

? ⟵ ₹−1,17,800

⇒ −1.59%

IRR = 15 − 1.59 = 13.41%.

Step 4: Calc of Pay back period

Year	CF	Cumulative CF
2	₹2,50,000	₹2,50,000
3	₹3,00,000	₹5,50,000
4	₹3,50,000	₹9,00,000
5	₹4,00,000	₹13,00,000
6	₹4,00,000	₹17,00,000

Assuming non-discounted pay back, the capital outlay of ₹17,00,000 is recovered back in 6 years.

(Q5) In this question, the project is having O/F 2 times at the T_0 and T_1. Since, nothing is said about timing of inflows, it is assumed to start from T_1 itself. It is to be noted that T_1 & T_2 CFs shall be adjusted to side affects in the form of sales promotion.

Step 1: Calc of contribution

SP/U	:	₹3
VC/U	:	(₹1.75)
C/U	:	₹1.25
NOU	:	50,000
Contribution	:	₹62,500

Step 2: Calc of NPV

Year	0	1	2	3	4	5
O/F	(₹1,00,000)	(₹25,000)	-	-	-	-
I/F	—	₹62,500	₹62,500	₹62,500	₹62,500	₹62,500
Sales promo	—	(₹10,000)	(₹15,000)	—	—	—
Scrap	—	—	—	—	—	₹30,000
Fixed* Cost	—	(₹21,000)	(₹21,000)	(₹21,000)	(₹21,000)	(₹21,000)
Net CF	(₹1,00,000)	₹6,500	₹26,500	₹41,500	₹41,500	₹71,500
PV@10%	1	0.909	0.826	0.751	0.683	0.621
DISCF	(₹1,00,000)	₹5,909	₹21,889	₹31,167	₹28,345	₹44,402

NPV = DISCI − DISCO
= ₹1,31,712 − ₹1,00,000
= +₹31,712.

Notes:

1. Since, tax is not given, depreciation has no impact on decision making.
2. While calculating CFs, FC shall be considered net of depreciation since, depreciation is not a real CF of that year.

Depreciation p.a (SLM) = $\frac{\text{Cost} - \text{Salvage value}}{\text{Life}}$

= $\frac{₹1,25,000 - ₹30,000}{5}$

= ₹95,000/5

= ₹19,000 p.a.

Net FC p.a = ₹40,000 − ₹19,000 = ₹21,000.

(Q6.) In this question, the company want to analyse the project not on the basis of inflows, but on the basis of outflows. However both projects are not of equal lives. Hence, we need to calculate Equated annuity cost.

Step 1: Calc of PV of running cost

Particulars	M(X)	M(Y)
Running cost p.a.	₹4,00,000	₹6,00,000
PVAF	2.531	1.759
PV of running cost	₹10,12,400	₹10,55,400

Step 2: Calc of EAC

Particulars	M(X)	M(Y)
1. machine cost	₹15,00,000	₹10,00,000
2. PV of running cost	₹10,12,400	₹10,55,400
3. Total OCF (PV)	₹25,12,400	₹20,55,400
4. PVAF	2.531	1.759
5. EAC (St. 3/St. 4)	₹9,92,651	₹11,68,505

since, EAC of machine 'X' is less, it is therefore recommended to go with that machine.

(Q8.) Step 1: Calc of Net CF p.a

Particulars	Amount (₹)
Revenues	1,20,000
(−) op. cost	(22,500)
(−) Depreciation ⊛	(22,750)
EBIT	74,750
(−) Tax @ 30%	(22,425)
EAT	52,325
(+) Depreciation	22,750
(−) Loss of commission	(36,000)
Net cash inflow	39,075

Step 2: Calc of NPV

Year	CF (₹)	PV@10%	PVCF (₹)
0	(2,00,000)	1	(2,00,000)
1−8	39,075	5.335	2,08,465
8	18,000	0.467	8,406
NPV			+16,871

Step 3: Calc of Profitability index

$$\text{Profitability index} = \frac{DISCI}{DISCO}$$

$$= \frac{₹2,16,871}{₹2,00,000}$$

$$= 1.084 \text{ times.}$$

⊛ Depreciation

$$\frac{\text{Cost} - SV}{\text{Life}} = \frac{₹2,00,000 - ₹18,000}{8}$$

$$= ₹22,750.$$

Conclusion:

since, NPV of the project is positive and P.I is more than '1', the project is acceptable.

Illustration 18:

Step1: Calculation of Net cost of new machine

Cost of new machine = ₹ 4,50,000

(-) Exchange inflow = ₹ (1,00,000)

Net cost of new machine = ₹ 3,50,000

Step2: Calculation of incremental inflows

Particulars	Old machine (₹)	New machine (₹)
PBT	3,24,750	3,87,250
(+) Depn wrongly calc as per SLM	24,000	41,500
Adj. PBT	3,48,750	4,28,750

Incremental = ₹80,000

Step3: Depreciation schedule

Year	Opg. bal (₹)	Depn	Clg. bal (₹)
1	3,50,000	26,250	3,23,750
2	3,23,750	24,281	2,99,469
3	2,99,469	22,460	2,77,009
4	2,77,009	20,776	2,56,233
5	2,56,233	19,217	2,37,016
6	2,37,016	17,776	2,19,240
7	2,19,240	16,443	2,02,797
8	2,02,797	15,210	1,87,587
9	1,87,587	14,069	1,73,518
10	1,73,518	13,014	1,60,504

Notes on depreciation:-

1. In the books, depreciation is calculated as per SLM. However, for tax savings on depreciation, we should follow IT rates which is 7.50% in the given case @ WDV.
2. Hence, the depn on SLM basis in the books is added back to PBT resulting in PBDT and then depn calculated as per WDV shall be deducted to arrive at PBT.

Step 4: CF schedule (Amount in ₹)

Year	PBDT	Depn	PBT	Tax	PAT	CF	PV@10%	PVCF
1	80,000	26,250	53,750	16,125	37,625	63,875	0.909	58,062
2	80,000	24,281	55,719	16,716	39,003	63,284	0.826	52,273
3	80,000	22,460	57,540	17,262	40,278	62,738	0.751	47,116
4	80,000	20,776	59,224	17,767	41,457	62,233	0.683	42,505
5	80,000	19,217	60,783	18,235	42,548	61,765	0.621	38,356
6	80,000	17,776	62,224	18,667	43,557	61,333	0.564	34,592
7	80,000	16,443	63,557	19,067	44,490	60,933	0.513	31,2 9
8	80,000	15,210	64,790	19,437	45,353	60,563	0.467	28,2 3
9	80,000	14,069	65,931	19,779	46,152	60,221	0.424	25,5 4
10	80,000	13,014	66,986	20,096	46,890	59,904	0.386	23,1 3
10 (Salvage)	35,000	–	–	–	–	–	0.386	13,510

DISC1	₹3,94, 13
(–) DISCO	(₹3,50, 00)
+NPV	₹44,6

Since, NPV is positive, replacing old machine with a new machine is acceptable.

Practical problems

(Q2) 1.

Particulars	Machine-A (₹)	Machine-B (₹)
Cost of machine	5,00,000	5,00,00
(–) Salvage value of old machine	(1,00,000)	(1,00,000
Net cost of new machine	4,00,000	4,00,00
(+) Addl utilities cost	1,00,000	2,00,00
(–) Salvage value of old utilities	–	(20,00
DISCO	5,00,000	5,80,00

2. Calc of NPV of both machines

Year	PV@15%	CF(A)	PVCF(A)	CF(B)	PVCF( )
1	0.870	1,00,000	87,000	2,00,000	1,74,0 0
2	0.756	1,50,000	1,13,400	2,10,000	1,58,7 0
3	0.658	1,80,000	1,18,440	1,80,000	1,18,4 0
4	0.572	2,00,000	1,14,400	1,70,000	97,240
5	0.497	1,70,000	84,490	40,000	19,880
5	0.497	50,000	24,850	60,000	29,820
(S.V)					
DISCI			5,42,580		5,98,140
(-) DISCO			(5,00,000)		(5,80,000)
NPV			+ 42,580		+ 18,140

Conclusion:

From NPV POV, machine A is preferred to machine B.

3. Calc of Discounted PBP

For Machine - A

Year	DCF	CDCF
1	87,000	87,000
2	1,13,400	2,00,400
3	1,18,440	3,18,840
4	1,14,400	4,33,240
5	84,490	5,17,730
5	24,850	5,42,580

PBP = 4 years + 0.611 yrs ⊛

* 1 year ⟶ 1,09,340

? ⟵ 66,760

= 4.611 yrs.

For machine - B

Year	DCF	CDCF
1	1,74,000	1,74,000
2	1,58,760	3,32,760
3	1,18,440	4,51,200
4	97,240	5,48,440
5	19,880	5,68,320
5	29,820	5,98,140

PBP = 4 years + 0.635 ⊛

* 1 year ⟶ 49,700

? ⟵ 31,560

= 4.635 yrs.

Project A is recommended since it is giving recovery of outflow at a lesser time.

4. calc of desirability factor (P.I)

$$PI = \frac{DISCI}{DISCO}$$

$$M(A) = \frac{₹5,42,580}{₹5,00,000} = 1.085$$

$$M(B) = \frac{₹5,98,140}{₹5,80,000} = 1.031$$

Since, the desirability factor of M(A) is high, it is recommended to accept M(A) for replacement decision.

Notes:

* This is not a incremental CF question since, there 2 machines A & B for replacement and we need to choose one among.
* salvage on old utilities can be taken only by machine B, because it donot use those utilities like machine A.
* PBP is calculated considering salvage value also.

(Q 7) Step 1: Calculation of NPV if servicing is opted

Year	CF (₹)	PV @ 10%	PVCF
0	(1,00,000)	1	(₹1,00,000)
1	36,000	0.909	32,724
1	(20,000)	0.909	(18,180)
2	36,000	0.826	29,736
3	36,000	0.751	27,036
3	25,000	0.751	18,775
		NPV =	−9,909

If supplier gives a discount of ₹10,000 @ T0, then NPV would be −₹9,909 + ₹10,000 = ₹91

Notes:

1. In this case, the machine is subjected to servicing at the end of year-1 @ ₹20,000, therefore, it is an outflow for year-1.

2. In such a case, NPV is negative and project is not acceptable. But, if the supplier offers a discount of ₹10,000 at year (0), NPV is +₹91 and hence it is in hands of management whether to accept (or) to reject the decision.

Step 2: Calculation of NPV if machine is replaced at the end of year-2

Year	Event	CF (₹)	PV@10%	PVCF
0	Investment	(1,00,000)	1	(1,00,000)
1	Inflow	36,000	0.909	32,724
2	Inflow	36,000	0.826	29,736
2	Replacement O/F	(30,800)	0.826	(25,441)
3	Inflow	36,000	0.751	27,036
4	Inflow	36,000	0.683	24,588
4	Salvage	18,000	0.683	12,294
			NPV	= +₹937

If supplier gives a discount of ₹10,000 @ yr-0, then, NPV is ₹937 + ₹10,000 = ₹10,937.

Conclusion:

Whether with/without a discount, replacement is recommended.

(Q.12) Step 1: Calc of EAC of new machine

1. Cost of new machine = ₹90,000
2. PV of maintanance costs = ₹44,870
   (₹10,000 × 4.487)
3. PV of salvage value = (₹6,540)
   (₹20,000 × 0.327)
4. Net cost = ₹1,28330
5. Equated annuity cost = ₹28,600.

$$\frac{O/F}{PVAF} = \frac{₹1,28,330}{4.487}$$

Step 2: Replacement decision

A. If replacement is immediate

If asset is replaced immediately, then there would be no maintenance costs and company would receive a hefty salvage value of ₹ 40,000. moreover, company will incur EAC of ₹ 28,600 today.

T_0	1. maintenance Cost (MC)	= ₹0
	2. EAC	= (₹28,600)
	3. Salvage	= ₹40,000
	Net inflow	= +₹ 11,400

B. If replacement is made in yr-1

If asset is replaced at the end of year-1, it shall incur maintenance costs for year-1, EAC after 1 year & salvage receipt after 1 year.

T_1	1. maintenance costs (₹10,000 X 0.870)	= (₹8,700)
	2. EAC (₹28,600 X 0.870)	= (₹24,882)
	3. salvage value (₹25,000 X 0.870)	= ₹21,750
	4. Net O/F	= ₹11,832

C. If replacement is made in year 2

T_1	1. maintenance costs (₹10,000 X 0.870)	= (₹8,700)
T_2	1. maintenance costs (₹20,000 X 0.756)	= (₹15,120)
	2. EAC (₹28,600 X 0.756)	= (₹21,622)
	3. salvage value (₹15,000 X 0.756)	= ₹11,340
	Net O/F	= (₹34,102)

D. If replacement is made in year-3

T1	maintenance costs (₹10,000 X 0.870)	= (₹8,700)
T2	maintenance costs (₹20,000 X 0.756)	= (₹15,120)
T3	1. maintenance costs (₹30,000 X 0.658)	= (₹19,740)
	2. EAC (₹28,600 X 0.658)	= (₹18,819)
	3. salvage value (₹10,000 X 0.658)	= ₹6,580
	Net O/F	= ₹55,799

E. If replacement is made at the end of yr4

T1	maintenance costs (₹10,000 X 0.870)	= (₹8,700)
T2	maintenance costs (₹20,000 X 0.756)	= (₹15,120)
T3	maintenance costs (₹30,000 X 0.658)	= (₹19,740)
T4	1. maintenance costs (₹40,000 X 0.572)	= (₹22,880)
	2. EAC (₹28,600 X 0.572)	= (₹16,359)
	3. salvage	= —
	Net O/F	= ₹82,799

Summary

1. Replacement @ yr0	=	₹11,400 (I/F)
2. Replacement @ yr1	=	₹11,832 (O/F)
3. Replacement @ yr2	=	₹34,102 (O/F)
4. Replacement @ yr3	=	₹55,799 (O/F)
5. Replacement @ yr4	=	₹82,799 (O/F)

It is recommended to replace the machine immediately.

(Q.13) Step1: Calculation of Net savings (after tax)

The company before the new decision used to dispose off the waste @ ₹1 per Gallon. Therefore, it has an outflow of ₹50,000 (₹1 x 50,000 Gallons) every year. Due to new investment decision, company is not going to dispose the waste, rather it processes the wastes and sell @ ₹10/Gallon. Hence, ₹50,000 outflow for disposal of wasted is saved by new decision. Savings is a deemed inflow. In CB, all inflows will raise to tax outflows and all outflows will entail tax inflows.

∴ Net savings = ₹ 50,000 p.a x 0.50
= ₹ 25,000 p.a.

Step2: Calc of PV of annuity savings

Savings (Net) p.a x PVAF (given)
= ₹ 25,000 x 5.019 (given)
= ₹ 1,25,475.

Step3: Calc of Net O/F initially

Cost of new machine = ₹ 6,00,000
(-) Annuity Savings (Step2) = (₹ 1,25,475)
Net O/F = ₹ 4,74,525

Step4: Calc of Depreciation p.a

$$SLM = \frac{\text{Cost} - \text{Salvage}}{\text{Life}}$$

$$= \frac{₹\,6,00,000 - 0}{10}$$

= ₹ 60,000 p.a.

Step 5: Calc of cash inflows

Particulars	Amt (₹)
1. Sale of processed waste (₹10/U x 50,000 Gallons)	5,00,000
2. Variable cost (₹5/U x 50,000 Gallons)	(2,50,000)
3. Contribution	2,50,000
4. Fixed cost	(30,000)
5. Advt. Costs	(20,000)
6. Depreciation (Step 4)	(60,000)
7. EBIT [3 − (4 + 5 + 6)]	1,40,000
8. Tax @ 50%	(70,000)
9. EAT	70,000
10. Depreciation	60,000
CASH INFLOW P.A	1,30,000

Step 6: Calc of PV of annuity cash flows

PV of ACF = Cash flow p.a x PVAF

= ₹1,30,000 x 5.019

= ₹ 6,52,470

Step 7: Calc of NPV of decision

NPV = DISCI − DISCO

= ₹ 6,52,470 − ₹ 4,74,525

= ₹ 1,77,945

Conclusion:-

Since, the NPV of project is positive, it recommended to process the waste and sell.

Note:

Research cost of ₹60,000 is not considered in investment decision since it is already incurred & is a sunk cost.

(Q4) Calculation of NPV of various project combinations

Project	O/F (₹)	DISCI (₹)	NPV (₹)
1	2,00,000	2,90,000	+ ₹90,000
2	1,15,000	1,85,000	+ ₹70,000
3	2,70,000	4,00,000	+ ₹1,30,000
1 & 2	3,15,000	4,75,000	+ ₹1,60,000
1 & 3	4,40,000 (Economies of invst)	6,90,000	+ ₹2,50,000
2 & 3	3,85,000	6,20,000 (Synergic gain)	+ ₹2,35,000
1, 2 & 3 (*)	6,80,000	9,10,000	+ ₹2,30,000

(*) Working note:

a. Calc of O/F

1 & 3 (economies)	=	₹ 4,40,000
2	=	₹ 1,15,000
Addl. invst	=	₹ 1,25,000
Total O/F	=	₹ 6,80,000

b. Calc of DISCI

2 & 3 (Synergy)	=	₹ 6,20,000
1	=	₹ 2,90,000
Total	=	₹ 9,10,000

Conclusion :-

Project 1 & 3 combination is recommended since it is giving optimum NPV out of all.