7

CHAPTER

Investment Decisions

THEORY

Meaning of Capital Budgeting	❑ Capital budgeting may be defined as the whole process of planning expenditure which aims at maximizing the long term profitability. ❑ The capital budgeting decisions have enormous impact on the basic character of the firm on a long-term basis. ❑ The decisions normally involve substantial outlays and are generally irreversible without incurring substantial losses.
Need for capital budgeting	(*a*) Involvement of huge funds (*b*) Irreversible decisions (*c*) Vitally affects profitability and financial position (*d*) Long term implications (*e*) Most difficult to make (*f*) Wealth maximization of shareholders (*g*) Maintaining firm's competitive position
Steps in capital budgeting process	(*a*) Planning (*b*) Evaluation (*c*) Selection (*d*) Implementation (*e*) Control (*f*) Follow-up or review
Data required for use of capital budgeting techniques	(i) Costs and benefit of proposal (ii) Required rate of return (iii) Economic life of the project (iv) Available funds (v) Risk of Obsolescence (vi) Depreciation (vii) Estimates of opportunity cost (viii) Intangible factors

Types of Capital Budgeting Decisions	❑ **On the basis of Firm's Existence** ❍ Replacement & Modernization decisions ❍ Expansion decisions ❍ Diversification decisions ❑ **On the basis of Decision Situation** ❍ Independent Projects or Accept-reject decisions ❍ Mutually Exclusive Projects ❍ Complementary Projects or Dependable Projects
Cash Flows	❑ Capital outflows ❑ Working capital outflows ❑ Net Revenue cash inflows (Revenue outflow – Revenue Inflow) ❑ Terminal value
Meaning of time value of money	Time value of money means that worth of a rupee received today is different from the worth of a rupee to be received in future. The preference of money now as compared to future money is known as time preference for money.
Reasons for using time value of money	❑ **Risk —** there is uncertainty about the receipt of money in future. ❑ **Preference for present consumption —** Most of the persons and companies in general, prefer current consumption over future consumption. ❑ **Inflation —** In an inflationary period a rupee today represents a greater real purchasing power than a rupee a year hence. ❑ **Investment opportunities —** Most of the persons and companies have a preference for present money because of availabilities of opportunities of investment for earning additional cash flow.
Present Value	Present value is the current value of a future amount. It can also be defined as the amount to be invested today (Present value) at a given rate over specified period to equal the future amount.
Perpetuity	Perpetuity is an annuity in which the periodic payments or receipts begin on a fixed date and continue indefinitely or perpetually. Fixed coupon payments on permanently invested (irredeemable) sums of money are prime examples of perpetuity.
Accounting Rate of Return (ARR)	❑ It is the average annual yield earned on the project. It is calculated by dividing the annual average profits after taxes by the initial or average investments. ❑ When initial investment is taken, it is called Return on Investment (ROI) and when we use average investment, it is called Average Rate of Return (ARR). ❑ $ARR = \frac{\text{Annual Average Earnings After Tax}}{\text{Average Investment}} \times 100$

Merits of Accounting Rate of Return	(*a*) It is easy to understand and calculate (*b*) It considers the entire profits over the entire life of the projects (*c*) It uses the accounting data with which managers are familiar.
Demerits of Accounting Rate of Return	(*a*) It ignores the time value of money. (*b*) It does not use the cash flows. (*c*) There is no objective way to calculate the minimum acceptable rate of return. (*d*) In this method, the income and investment words are used which have got many meanings. So there is uncertainty.
Payback Period (PBP)	❑ It is the time that is required for a stream of cash flows (i.e. cash inflows) from an investment to recover the original cash outlays required by the investment. ❑ **If Annual Cash Inflows are equal:** $\text{PBP} = \frac{\text{Initial Cash Outflows}}{\text{Annual Cash Inflow}}$ ❑ **If Annual Cash Inflows are unequal:** PBP = Years upto which Cummulative CFAT is less than Total Cash Outflows $+\left(\frac{\text{Total Cash Outflow - Cummulative CF in which CF is less than total cash outflow}}{\text{CFAT for the next year for which Cummulative CFAT was considered in numerator}}\right)$
Merits of Payback Period	(*a*) It is easy to understand and calculate (*b*) It emphasis liquidity by stressing earlier cash inflows. (*c*) It uses cash flows rather than accounting data which is more realistic. (*d*) It enables the management to cope with the risk associated with the project by having a shorter payback period. (*e*) Projects in which the technological development is quite fast and there is more risk of obsolescence, then such projects are chosen in which the payback period is quite small.
Demerits of Payback Period	(*a*) It ignores the time value of money. (*b*) It ignores the cash flows occurring after the payback period. (*c*) There is no objective way to determine the maximum acceptable payback period. (*d*) It does not necessarily maximize the wealth of the shareholders (*e*) The cost of capital is the strong basis for investment decisions but this method ignores cost of capital. (*f*) This method does not measure risks in the project. If a project has shorter payback period but more risk, it may be accepted which is not good.

Payback Reciprocal	It is the reciprocal of payback period. It is close approximation of internal rate of return. $\text{Payback Reciprocal} = \frac{\text{Annual Average cash inflows}}{\text{Initial Investment}}$
Discounted Payback Period (Disc. PBP)	❑ It refers to the period within which the entire cost of the project is expected to be completely recovered by way of discounted cash inflows Disc. PBP = Years upto which Commulative PV of CFAT is less than PV of Cash Outflows $+\left(\frac{\text{PV of Cash Outflow - Cummulative PV of CF in which CF is lesss than PV of cash outflow}}{\text{PV of CF for the next year for which Cummulative PV of CF was considered in numerator}}\right)$
Merits of Discounted Payback Period	(*a*) It is easy to understand and calculate. (*b*) It considers the time value of money. (*c*) It emphasis liquidity by stressing earlier cash inflows (*d*) It uses the cash flows rather than accounting data. (*e*) It enables management to cope with the risk associated with the project by having a shorter payback period.
Demerits of Discounted Payback Period	(*a*) It ignores the cash flows occurring after the payback period. (*b*) There is no objective way to determine the maximum acceptable payback period. (*c*) It is not a measure of profitability since the cash flows occurring after the payback period are ignored. (*d*) It does not necessarily maximize the wealth of the shareholders.
Net Present Value	❑ The net present value method uses a specified discount rate to bring all subsequent net cash inflows after the initial investment to their present values (the time of the initial investment or year 0). ❑ The Net Present Value is obtained by subtracting the present value of cash outflows from the present value of cash inflows. ❑ $\text{NPV} = \frac{CF_0}{(1+k)^0} + \frac{CF1}{(1+k)^1} + \ldots + \frac{CF_n}{(1+k)^n} - CO_0$
Merits of NPV	(*a*) It recognizes the time value of money (*b*) It considers entire cash flows over entire life of the project. (*c*) It is consistent with the objective of maximizing the wealth of owners since NPV may be interpreted as an immediate increase in firm's wealth if the project is accepted. (*d*) It enables the comparison of relative profitability between projects of different life span and cash inflows occurring at different times.

Demerits of NPV	(*a*) It requires the estimation of cash inflows and cash outflows, which is a difficult task. (*b*) It requires the computation of the cost of capital to be used as discount rate. (*c*) It is a difficult concept to understand in case of mutually exclusive projects when projects involve different amount of cash outflows.
Internal Rate of Return (IRR)	❑ It is the highest rate of interest, which a firm would be ready to pay on funds borrowed to finance the project without being financially worse off by repaying loan along with interest thereon out of cash inflows generate by the project. ❑ In other words, it is the rate at which NPV is zero. ❑ $\text{IRR} = \text{Lower Rate} + \left(\frac{\text{Lower rate NPV}}{\text{Lowe rate NPV - Higher rate NPV}} \right)$ (Higher Rate - Lower Rate)
Merits of IRR	(*a*) It considers the time value of money. (*b*) It considers entire cash flows over entire life of the project. (*c*) It is consistent with the objective of wealth maximization of owner. (*d*) It is not based upon assumed cost of capital.
Demerits of IRR	(*a*) It is difficult to understand and compute. (*b*) The method is based upon an assumption of reinvestment rate of intermediate cash flows being the same as IRR of each individual project. (*c*) The estimation of appropriate rate of discount is quite difficult. (*d*) It may yield multiple IRR under circumstances when project cash flows reverse during the life of the project.
Multiple IRR	In cases where project cash flows change signs or reverse during the life of a project e.g. an initial cash outflow is followed by cash inflows and subsequently followed by a major cash outflow , there may be more than one IRR.
Profitability Index Or Desirability Factor	❑ Profitability index is the ratio of present value of cash inflows to the present value of cash outflow i.e. investment. ❑ It is also known as Benefit-Cost Ratio. ❑ $\text{Profitability Index} = \frac{\text{PV of Cash inflow}}{\text{PV of cash outflows}}$ $= \frac{\text{Present Value of cash Inflows}}{\text{Present Value of cash Outflows}}$

Merits of Profitability Index	(*a*) In this method, full life of the project is taken into consideration. (*b*) It considers time value of money (*c*) It helps in determination of most desirable project mix in case of capital rationing when projects are divisible. (*d*) It helps in selection of mutually exclusive projects having same NPV.
Demerits of Profitability Index	(*a*) It is based on cost of capital which is difficult to calculate. (*b*) It does not provide satisfactory result in case of mutually exclusive projects having unequal lives. (*c*) It fails in determination of most desirable project mix in case of capital rationing when projects are indivisible.
Reasons for difference between NPV and IRR	(*a*) Scale or size disparity (*b*) Time disparity in cash flows (*c*) Disparity in life of proposals (unequal lives)
Similarities between NPV & IRR	(*a*) Both techniques uses Discounted Cash Flow Method i.e., both are Time Adjusted Techniques of Evaluation of Capital Project Proposals. (*b*) Both take into account the Cash Flows After Tax (CFAT) over the entire life of the Project. (*c*) Both are, consistent with the objective of maximizing the wealth of shareholders. (*d*) Both are difficult to compute. (*e*) Both the techniques may often give contradictory results especially in case of mutually exclusive projects.
Differences between NPV & IRR	(*a*) NPV uses the firm's cost of capital as the rate of discount. Unless the cost of capital is known. NPV technique cannot be applied. Whereas calculation of cost of capital is not the pre-requisite to apply IRR. (*b*) NPV may mislead while dealing with alternative projects or limited funds under the conditions of unequal lives. IRR allows a sound comparison of the project having different lives and different timings of cash inflows. (*c*) NPV may give different ranking in case of complicated projects as comparison to IRR. (*d*) NPV assumes that intermediate cash flows are reinvested at firm's cost of capital whereas IRR assumes that intermediate Cash Inflows are reinvested at the internal rate of the project. (*e*) IRR method favours short-term projects so long as it promises return in excess of cut-off rate whereas NPV method favours long-term projects. (*f*) IRR may give negative rate or multiple rates under certain circumstances. NPV does not suffer from the limitation of multiple rates.

NPV is superior to IRR because:	(*a*) NPV is simple to compute as compared to IRR. (*b*) NPV does not suffer from the limitation of multiple rates. (*c*) NPV assumes that intermediate cash flows are reinvested at firm's cost of capital. The reinvestment assumption of NPV is more realistic than IRR method.
IRR is favoured than NPV because:	(*a*) IRR is easier to visualize and to interpret as compared to NPV method, (*b*) Even in the absence of cost of capital, IRR gives an idea of project's profitability (*c*) IRR method is preferable to NPV in the evaluation of risky projects. In general, to resolve the inconsistency, it is necessary to have common (*i*) terminal date and (ii) expected reinvestment rate and calculate thereby the Terminal Value of the Project.
Modified Internal Rate of Return (MIRR)	❑ Under this method, all cash flows , apart from the initial investment, are brought to the terminal value using an appropriate discount rate(usually the Cost of Capital). ❑ This results in a single stream of cash inflow in the terminal year. The MIRR is obtained by assuming a single outflow in the zero year and the terminal cash inflow as mentioned above. ❑ The discount rate which equates the present value of the terminal cash in flow to the zero year outflow is called the MIRR. ❑ In other words, MIRR is the rate of compounding which makes the initial cash outflow in zero year equal to the terminal value of the cash inflows. ❑ Algebraically: Initial cash Outflow $(1 + r)^{nth}$ = Total Terminal value of all Cash Inflows Where, r = Modified Internal Rate of Return
Merits of MIRR	(*a*) It considers time value of money (*b*) It considers entire cash flows over entire life of the project (*c*) It is consistent with the objective of maximizing the wealth of owners (*d*) It is a measure of profitability since entire cash flows over entire life of the project are considered
Demerits of MIRR	(*a*) It requires the estimation of cash inflows and cash outflows, which is a difficult task (*b*) It is relatively difficult to compute. (*c*) It ignores the absolute amount of NPV while taking decision. A project having lower IRR but higher absolute NPV may be rejected although it increases the shareholder's wealth.

Capital Rationing	(*a*) **Projects are independent and divisible –** In this case decision will be based on NPV per rupee of capital or Profitability index. (*b*) **Projects are not divisible –** In this case, decision will be based on absolute NPV by making various possible combinations within the spending limit.
Projects with unequal lives	It can be delt by following methods: (*a*) Replacement chain method (*b*) Equivalent annualized criterion
Cut-Off Rate	It is the minimum rate which the management wishes to have from any project. Usually this is based upon the cost of capital. The management gains only if a project gives return of more than the cut-off rate. Therefore, the cut-off rate can be used as the discount rate or the opportunity cost rate.

PRACTICAL QUESTIONS

1. SK Ltd. provides you the following information:

Purchase price	₹80,000
Installation charges	₹20,000
Estimated salvage value at the end of useful life	₹40,000
Useful life	4 years
Working capital required	₹10,000
Annual earnings before depreciation and tax	₹65,000
Tax rate	30%

Calculate the Accounting Rate of Return if the method of Depreciation is

(*a*) Straight line method;

(*b*) Written down value method (assuming depreciation @ 20%).

[**Sol.** (*a*) 43.75%; (*b*) 46.02%]

2. From the following data calculate cash flows from operations:

Year	1	2	3	4	5
Sales	30,000	50,000	80,000	2,00,000	10,00,000

- Variable cost 40%
- Fixed cost ₹2,000
- Cost of assets ₹50,000
- Life 5 years
- Tax rate 30%

[**Sol.** ₹14,200; 22,600; ₹35,200; ₹85,600; ₹4,21,600]

3. From the following data calculate cash flows from operations:

Year	1	2	3	4	5
Sales	30,000	50,000	80,000	2,00,000	10,00,000

- Variable cost 30%
- Fixed cost ₹5,000
- Cost of assets ₹1,40,000
- Life 5 years
- Tax rate 30%

[**Sol.** ₹19,600; ₹29,400; ₹44,100; ₹1,02,900; ₹4,94,900]

4. From the following data calculate cash flows from sales of assets if assets is sold for (*a*) ₹7; (*b*) ₹10 and (*c*) ₹16:

- Cost of assets ₹1,000
- Life 5 years
- Scrap ₹10
- Tax 30%

[**Sol.** (*a*) ₹7.90; (*b*) ₹10; (*c*) ₹14.20]

5. From the following data calculate cash inflows (*a*) if complete block is sold and (*b*) there are other remaining assets in block:

Year	1	2	3	4	5
Sales	40,000	50,000	80,000	2,00,000	10,00,000

- Variable cost 30%
- Fixed cost ₹3,000
- Cost of assets ₹1,30,000
- Scrap value ₹5,000
- Life 5 years
- Tax rate 30%
- Depreciation 20% WDV

[**Sol.** (*a*) ₹25,300; ₹28,640; ₹42,092; ₹99,894; ₹5,07,374; (*b*) ₹25,300; ₹28,640; ₹42,092; ₹99,894; ₹4,95,795]

6. From the following data calculate pay back period:

Year	1	2	3	4	5
Profit before depreciation	40,000	60,000	2,00,000	3,00,000	10,00,000

- Variable cost 30%
- Fixed cost ₹15,000
- Cost of assets ₹3,00,000
- Working capital ₹50,000
- Life 5 years
- Tax rate 30%

[**Sol.** 3,377 years]

7. From the following data calculate pay back period:

Year	1	2	3	4	5
Profit after depreciation & tax	40,000	60,000	2,00,000	3,00,000	10,00,000

Variable cost	30%
Fixed cost	₹30,000
Cost of assets	₹4,37,500
Scrap value	₹30,000
Working capital	₹20,000
Life	5 years
Depreciation	20% WDV
Tax rate	30%

[**Sol.** 2.78 years]

8. From the following data calculate

(*a*) pay back period and (*b*) discounted pay back period:

- Cost of project ₹2,50,000
- Annual cash inflow ₹90,000 upto 4 years and ₹10,00,000 in 5th year
- Cut off rate 9%

[**Sol.** (*a*) 2.78 years; (*b*) 3.35 years]

9. From the following data calculate discounted pay back period:

Year	1	2	3	4	5
Profit before depreciation & tax	40,000	60,000	2,00,000	3,00,000	10,00,000

- Variable cost 30%
- Fixed cost ₹25,000
- Cost of assets ₹3,20,000
- Scrap value ₹20,000
- Working capital ₹30,000
- Life 5 years
- Depreciation Sum of Year's Digit Method
- Tax rate 30%
- Minimum required return 11%

[**Sol.** 3.88 years]

10. From the following data calculate discounted pay back period:

Year	1	2	3	4
Profit before tax	10,000	15,000	40,000	1,00,000

- While computing above figures, depreciation was charged on straight line basis to write off an assets of ₹35,000 over 4 years to a ₹3,000 book value.

- Income tax rate at 30%.
- Written down value method at 20% is allowed as depreciation under income tax act.
- Minimum required return is 9%

[**Sol.** 2.24 years]

11. A Project requiring an investment of ₹10,00,000 and it yields profit after tax and depreciation which is as follows:

Year	Profit after tax and depreciation (₹)
1	50,000
2	75,000
3	1,25,000
4	1,30,000
5	80,000
Total	**4,60,000**

Suppose further that at the end of the 5th year, the plant and machinery of the project can be sold for ₹80,000. Determine average rate of return.

[**Sol.** 17.04%]

12. SK Company is evaluating three investment situations: (1) produce a new line of aluminium cookers, (2) expand its existing cooker line to include several new sizes and (3) develop a new, higher-quality line of cookers. If only the project in question is undertaken, the expected present values and the amounts of investment required are:

Project	Investment Required (₹)	Present value of future cash flows (₹)
1	2,00,000	2,90,000
2	1,15,000	1,85,000
3	2,70,000	4,00,000

If projects 1 and 2 are jointly undertaken, there will be no economies; the investment required and present values will simply be the sum of the parts. With project 1 and 3, economies are possible in investment because one of the machines acquired can be used in both production process. The total investment required for projects 1 and 3 combined is ₹4,40,000. If projects 2 and 3 are undertaken, there are economies to be achieved in marketing and producing the products but not in investment. The expected present value of future cash flows for projects 2 and 3 is ₹6,20,000. If all three projects are undertaken simultaneously, the economies noted will still hod. However, a ₹1,12,500 extension on the plant will be necessary, as space is not available for all three projects. Calculate NPV of the projects and state which project or projects should be chosen?

[**Sol.** NPV = ₹90,000; ₹70,000; ₹1,30,000; ₹1,60,000; ₹2,50,000; ₹2,35,000; ₹2,42,500]

13. Compute the net present value for a project with a net investment of ₹1,00,000 and net cash flows for year one is ₹55,000; for year two is ₹80,000 and for year three is ₹15,000. Further the company's cost of capital is 10%?

[PVIF @ 10% for three years are 0.909, 0.826 and 0.751]

[**Sol.** ₹27,340]

14. SK Ltd. is planning to invest in machinery, for which it has to make a choice between the two identical machines, in terms of Capacity, 'X' and 'Y'. Despite being designed differently, both machines do the same job. Further, details regarding both the machines are given below:

Particulars	Machine X	Machine Y
Purchase cost of the machine (₹)	15,00,000	10,00,000
Life (Years)	3	2
Running cost per year (₹)	4,00,000	6,00,000

The opportunity cost of capital is 9%. You are required to identify the machine the company should buy?

The present value (PV) factors at 9% are:

Year	t_1	t_2	t_3
$PVIF_{0.09,t}$	0.917	0.842	0.772

[**Sol.** PVCO = ₹25,12,400; ₹20,55,400]

15. A firm is in need of a small vehicle to make deliveries. It is intending to choose between two options. One option is to buy a new three wheeler that would cost ₹1,50,000 and will remain in service for 10 years.

The other alternative is to buy a second hand vehicle for ₹80,000 that could remain in service for 5 years. Thereafter the firm, can buy another second hand vehicle for ₹60,000 that will last for another 5 years. The scrap value of the discarded vehicle will be equal to it written down value (WDV). The firm pays 30% tax and is allowed to claim depreciation on vehicles @ 25% on WDV basis. The cost of capital of the firm is 12%.

You are required to advise the best option. **[Nov 2022]**

[**Sol.** New vehicle = ₹1,17,452; Second hand vehicle = ₹78,685]

16. SK ltd. is considering buying a new machine which would have a useful economic life of five years, a cost of ₹1,25,000 and a scrap value of ₹30,000, with 80 percent of the cost being payable at the start of the project and 20 percent at the end of the first year. The machine would produce 50,000 units per annum of a new project with an estimated selling price of ₹3 per unit. Direct cost would be ₹1.75 per unit and annual fixed costs, including depreciation calculated on straight-line basis, would be ₹40,000 per annum.

In the first year and the second year, special sales promotion expenditure, not included in the above costs, would be incurred, amounting to ₹10,000 and ₹15,000 respectively. Calculate NPV of the project for investment appraisal, assuming the company's cost of capital is 10 percent.

[SM, RTP Nov 2019, Similar RTP Nov 2023]

[**Sol.** NPV = ₹31,711]

17. SK Ltd. is planning to introduce a new product with a project life of 8 years. Initial equipment cost will be ₹3.5 crores. Additional equipment cost ₹25,00,000 will be purchased at the end of the third year from the cash inflow of this year. At the end of 8 years, the original equipment will have no resale value, but additional equipment can be sold for ₹2,50,000. A working capital of ₹40,00,000 will be needed and it will be released at the end of eight year. The project will be financed with sufficient amount of Equity capital. The sales volumes over eight years have been estimated as follows:

Year	1	2	3	4 & 5	6 – 8
Units	72,000	1,08,000	2,60,000	2,70,000	1,80,000

A sales price of ₹240 per unit is expected and variable expenses will amount to 60% of sales revenue. Fixed cash operating costs will amount to ₹36,00,000 per year. The loss of any year will be set off from the profits of subsequent two years. The company is subject to 30% tax rate and consider 12% to be an appropriate after tax cost of capital for this project. The company follows straight line method of depreciation. Required: Calculate the net present value of the project and advise the management to take appropriate decision. **[SM, Similar RTP May 2023]**

Note: The PV Factors at 12% are:

Year	1	2	3	4	5	6	7	8
PVIF	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404

[**Sol.** NPV = ₹1,61,13,079]

18. A chemical company is presently paying an outside firm ₹1 per gallon to dispose off the waste material resulting from its manufacturing operations. At normal operating capacity, the waste is about 50,000 gallons per year.

After spending ₹60,000 on research, the company discovered that the waste could be sold for ₹10 per gallon if it was processed further. Additional processing would however, require an investment of ₹6,00,000 in new equipment, which would have an estimated life of 10 years with no salvage value. Depreciation would be calculated by straight line method.

Except for the costs incurred in advertising ₹20,000 per year, no change in the present selling and administration expenses is expected, if the new product is sold. The details of additional processing costs are as follows:

Variable – ₹5 per gallon of waste put into process

Fixed (excluding depreciation) – ₹30,000 per year

In costing the new product, general administrative overheads will be allocated at the rate of ₹2 per gallon. There will be no losses in processing and it is assumed that the total waste processed in a given year will be sold in that year. Estimates indicate that 40,000 gallons, of the product could be sold each year. The management when confronted with the choice of disposing off the waste or processing it further and selling it, seeks your advice. Which alternative would you recommend? Assume that the firm's cost of capital is 15% and it pays on an average 35% tax on its income.

Note: Present value of annuity of ₹1 at 15% rate of discount for 10 years is 5.019. **[SM]**

[**Sol.** ₹1,25,246]

19. A large profit making company is considering the installation of a machine to process the waste produced by one of its existing manufacturing process to be converted into a marketable product. At present the waste is removed by a contractor for disposal on payment by the company of ₹150 lakhs per annum for the next four years. The contract can be terminated upon installation of the aforesaid machine on payment of a compensation of ₹90 lakhs before the processing operation starts. This compensation is not allowed as deduction for tax purposes.

The machine required for carrying out the processing will cost ₹600 lakhs to be financed by a loan repayable in 4 equal instalments commencing from the end of the year-1. The interest rate is 14% per annum. At the end of the 4th year, the machine can be sold for ₹60 lakhs and the cost of

dismantling and removal will be ₹45 lakhs. Sales and direct costs of the produce emerging from waste processing for 4 years are estimated as under:

	(₹in lakhs)			
Year	**1**	**2**	**3**	**4**
Sales	966	966	1,254	1,254
Material Consumption	90	120	255	255
Wages	225	225	255	300
Other expenses	120	135	162	210
Factory Overheads	165	180	330	435
Depreciation (as per income tax rules)	150	114	84	63

Initial stock of material required before commencement of the processing operation ₹60 lakhs at the start of year 1. The stock levels of material to be maintained at the end of year 1, 2 and 3 will be ₹165 lakhs and the stocks at the end of year 4 will be nil. The storage of materials will utilize space which would otherwise have been rented out for ₹30 lakhs per annum. Labour costs include wages of 40 workers, whose transfer to this process will reduce idle time payments of ₹45 lakhs in year 1 and ₹30 lakhs in year 2. Factory overheads include apportionment of general factory overheads except to the extent of insurance charges of ₹90 lakhs per annum payable on this venture. The company's tax rate is 30%. Present value factors for four years are as under:-

Year	1	2	3	4
PV Factors @ 14%	0.877	0.769	0.674	0.592

Advice the management on the desirability of installing the machine for processing the waste. All calculation should form part of the answer. **[SM, RTP Nov 2020]**

[**Sol.** ₹578.14 lakhs]

20. SK Lab Ltd. is using a X-ray machines which reached at the end of their useful lives. Following new X-ray machines of two different brands with same features are available for the purchase.

Brand	Cost of machine	Life of machine	Maintenance cost			Rate of depreciation
			Year 1-5	Year 6-10	Year 11-15	
XYZ	₹6,00,000	15 years	₹20,000	₹28,000	₹39,000	4%
ABC	₹4,50,000	10 years	₹31,000	₹53,000	...	6%

Residual Value of both of above machines shall be dropped by 1/3 of Purchase price in the first year and thereafter shall be depreciated at the rate mentioned above.

Alternatively, the machine of Brand ABC can also be taken on rent to be returned back to the owner after use on the following terms and conditions:

- Annual Rent shall be paid in the beginning of each year and for first year it shall be ₹1,02,000.
- Annual Rent for the subsequent 4 years shall be ₹1,02,500.
- Annual Rent for the final 5 years shall be ₹1,09,950.
- The Rent Agreement can be terminated by SK Labs by making a payment of ₹1,00,000 as penalty. This penalty would be reduced by ₹10,000 each year of the period of rental agreement.

You are required to:

(*a*) Advise which brand of X-ray machine should be acquired assuming that the use of machine shall be continued for a period of 20 years.

(*b*) Which of the option is most economical if machine is likely to be used for a period of 5 years?

The cost of capital of SK Labs is 12%. **[MTP May 2021]**

[Sol. (*a*) XYZ = ₹1,12,014; ABC = ₹1,15,360; Rent = ₹1,17,732; (*b*) XYZ = ₹4,99,732; ABC = ₹4,52,891; Rent = ₹4,41,643]

21. Alpha limited is a manufacturer of computers. It wants to introduce artificial intelligence while making computers. The estimated annual saving from introduction of the artificial intelligence (AI) is as follows:

- Reduction of five employees with annual salaries of ₹3,00,000 each.
- Reduction of ₹3,00,000 in production delays caused by inventory problem
- Reduction in lost sales ₹2,50,000 and
- Gain due to timely billing ₹2,00,000

The purchase price of the system for installation of artificial intelligence is ₹20,00,000 and installation cost is ₹1,00,000. 80% of the purchase price will be paid in the year of purchase and remaining will be paid in next year. The estimated life of the system is 5 years and it will be depreciated on a straight-line basis.

However, the operation of the new system requires two computer specialists with annual salaries of ₹5,00,000 per person.

In addition to above, annual maintenance and operating cost for five years are as below:

(Amount in ₹)

Year	1	2	3	4	5
Maintenance & Operating cost	2,00,000	1,80,000	1,60,000	1,40,000	1,20,000

Maintenance and operating cost are payable in advance.

The company's tax rate is 30% and its required rate of return is 15%.

Year	1	2	3	4	5
$PVIF_{0.10,t}$	0.909	0.826	0.751	0.683	0.621
$PVIF_{0.12,t}$	0.893	0.797	0.712	0.636	0.567
$PVIF_{0.15,t}$	0.870	0.756	0.658	0.572	0.497

Evaluate the project by using Net Present Value and Profitability Index. **[May 2022]**

[**Sol.** NPV = ₹8,36,557; PR = 1.41]

22. A share of the face value of ₹100 has current market price of ₹480. Annual expected dividend is 30%. During the fifth year, the shareholder is expecting a bonus issue in the ratio of 1:5. Dividend rate is expected to be maintained on the expanded capital base. The shareholder intends to retain the share till the end of the eighth year. At that time the value of share is expected to be ₹1,000. Incidental expenses at the time of purchase and sale are estimated at 5% on the market price. There is no tax on dividend income and capital gain. The shareholder expects a minimum return of 15% per annum. Should he buy the share? What is the maximum price he can pay for the share? Show complete workings.

[**Sol.** NPV = ₹13.18; Price = ₹492.55]

23. Suppose we have three projects involving discounted cash outflow of ₹5,50,000, ₹75,000 and ₹1,00,20,000 respectively. Suppose further that the sum of discounted cash inflows for these projects are ₹6,50,000, ₹95,000 and ₹1,00,30,000 respectively. Calculate the desirability factors for the three projects.

[**Sol.** 1.18; 1.27; 1.001]

24. SK Ltd. is planning its capital investment programmed for next year. It has five projects all of which give a positive NPV at the company cut-off rate of 15 percent, the investment outflows and present values being as follows:

Project	Investment (₹)	NPV @ 15% (₹)
A	(50,000)	15,400
B	(40,000)	18,700
C	(25,000)	10,100
D	(30,000)	11,200
E	(35,000)	19,300

The company is limited to a capital spending of ₹1,20,000. You are required to illustrate the return from a package of projects within the capital spending limit.

(*a*) The projects are independent of each other and are divisible (i.e. par-project is possible)

(*b*) Project C and D are dependent on each other and all other projects are divisible.

(*c*) The projects are independent of each other and are indivisible.

[**Sol.** (*a*) E, B, C, D; NPV = ₹55,567]

25. A company has following cash flows and its cost of capital is 10%.

Year	0	1	2	3	4
Cash flows	–2,00,000	60,000	90,000	1,30,000	70,000

Compute internal rate of return.

[**Sol.** 25.25%]

26. Given below are the data on a capital project 'S':

Annual cost saving	₹60,000
Useful life	4 years
Internal rate of return	15%
Profitability index	1.064
Salvage value	0

You are required to calculate for this project S:

(*a*) Cost of project

(*b*) Payback period

(*c*) Cost of capital

(*d*) Net Present Value

Given the following table of discount factors:

Discounting Factor	15%	14%	13%	12%
1 year	0.869	0.877	0.885	0.893
2 year	0.756	0.769	0.783	0.797
3 year	0.658	0.675	0.693	0.712
4 year	0.572	0.592	0.613	0.636
	2.855	2.913	2.974	3.038

[**Sol.** (*a*) ₹1,71,300; (*b*) 2.855 years; (*c*) 12%; (*d*) ₹10,980]

27. A company proposes to install machine involving a capital cost of ₹3,60,000. The life of the machine is 5 years and its salvage value at the end of the life is nil. The machine will produce the net operating income after depreciation of ₹68,000 per annum. The company's tax rate is 45%. The Net Present Value factors for 5 years are as under:

Discounting rate	14	15	16	17	18
Cumulative factor	3.43	3.35	3.27	3.20	3.13

You are required to compute the internal rate of return of the proposal.

[**Sol.** 15.74%]

28. An investment of ₹1,36,000 yields the following cash inflows (profit before depreciation but after tax). Determine MIRR considering 8% as cost of capital.

Year	₹
1	30,000
2	40,000
3	60,000
4	30,000
5	20,000
	1,80,000

[**Sol.** 9.45%]

29. SK Company is contemplating to replace one of its bottling machines with a newer and more efficient machine. The old machine was purchased at ₹10,00,000 and had a useful life of 10 years. The machine was bought 5 years back. The company does not expect to realize any return from scrapping the old machine at the end of 10 years but if it is sold now to another company in the industry, SK Company would receive ₹6,00,000 for it. The new machine has a purchase price of ₹20,00,000. It has an estimated salvage value of ₹2,00,000 and has useful life of 5 years.

The new machine will have a greater capacity and annual sales are expected to increase from ₹10,00,000 to ₹12,00,000. Operating efficiencies with the new machine will also produce savings of ₹2,00,000 a year. Depreciation is on a straight – line basis over useful life 5 years. The cost of capital is 8% and a 50% tax rate is applicable.

[**Sol.** ₹3,890]

30. SK Limited is thinking of replacing its existing machine by a new machine which would cost ₹60 lakhs. The company's current production is 80,000 units, and is expected to increase to 1,00,000 units, if the new machine is bought. The selling price of the product would remain unchanged at ₹200 per unit. The following is the cost of producing one unit of product using both the existing and new machine:

	Existing Machine (80,000 units)	New Machine (1,00,000 units)	Unit Cost (₹) Difference
Materials	75.0	63.75	(11.25)
Wages & Salaries	51.25	37.5	(13.75)
Supervision	20.0	25.0	5.0

	Existing Machine (80,000 units)	New Machine (1,00,000 units)	Unit Cost (₹) Difference
Repairs & Maintenance	11.25	7.5	(3.75)
Power & Fuel	15.5	14.25	(1.25)
Depreciation	0.25	5.0	4.75
Allocated Corporate Overheads	10.0	12.5	2.5
	183.25	**165.5**	**(17.75)**

The existing machine has an account book value of ₹1,00,000, and it has been fully depreciated for tax purpose. It is estimated that machine will be useful for 5 years. The supplier of the new machine has offered to accept the old machine for ₹2,50,000. However, the market price of old machine today is ₹1,50,000 and it is expected to be ₹35,000 after 5 years. The new machine has a life of 5 years and a salvage value of ₹2,50,000 at the end of its economic life. Assume corporate income tax rate of 40% and depreciation is charged on straight line basis for income tax purposes. Further assume that book profit is treated as ordinary income for tax purpose. The opportunity cost of capital of the company is 15%. Required: **[RTP Nov 2018]**

(*a*) Estimate net present value of the replacement decision

(*b*) Estimate the internal rate of return of the replacement decision

(*c*) Should company go ahead with the replacement decision? Suggest.

Year	1	2	3	4	5
$PVIF_{0.15,t}$	0.8696	0.7561	0.6575	0.5718	0.4972
$PVIF_{0.20,t}$	0.8333	0.6944	0.5787	0.4823	0.4019
$PVIF_{0.25,t}$	0.8000	0.6400	0.5120	0.4096	0.3277
$PVIF_{0.30,t}$	0.7692	0.5917	0.4552	0.3501	0.2693
$PVIF_{0.35,t}$	0.7407	0.5487	0.4064	0.3011	0.2230

[**Sol.** (*a*) ₹19,20,284; (*b*) 28.26%; (*c*) Yes]

31. SK Ltd. is contemplating replacement of one of its machines which has become outdated and inefficient. Its financial manager has prepared a report outlining two possible replacement machines. The details of each machine are as follows:

	Machine 1	Machine 2
Initial investment	₹12,00,000	₹16,00,000
Estimated useful life	3 years	5 years
Residual value	₹1,20,000	₹1,00,000
Contribution per annum	₹11,60,000	₹12,00,000
Fixed maintenance costs per annum	₹40,000	₹80,000
Other fixed operating cost per annum	₹7,20,000	₹6,10,000

The maintenance costs are payable annually in advance. All other cash flows apart from the initial investment assumed to occur at the end of each year. Depreciation has been calculated by straight line method and has been included in other fixed operating costs. The expected cost of capital for this project is assumed at 12%p.a.

Required to compute which machine is more beneficial, using annualized equivalent approach. Ignore tax. **[Dec 2021]**

Year	1	2	3	4	5	6
$PVIF_{0.12,t}$	0.893	0.797	0.712	0.636	0.567	0.507
$PVIFA_{0.12,t}$	0.893	1.690	2.402	3.038	3.605	4.112

[**Sol.** Machine 1 = ₹2,91,191; Machine – 2 = ₹3,72,291]

32. SK Ltd. has a machine which has been in operation for 3 years. The machine has a remaining estimated useful life of 5 years with no salvage value in the end. Its current market value is ₹2,00,000. The company is considering a proposal to purchase a new model of machine to replace the existing machine. The relevant information is as follows:

	Existing Machine	New Machine
Cost of machine	₹3,30,000	₹10,00,000
Estimated life	8 years	5 years
Salvage value	Nil	₹40,000
Annual output	30,000 units	75,000 units
Selling price per unit	₹15	₹15
Annual operating hours	3,000	3,000
Material cost per unit	₹4	₹4
Labour cost per hour	₹40	₹70
Indirect cash cost per annum	₹50,000	₹65,000

The company uses written down value of depreciation @20% and it has several other machines in the block of assets. The income tax rate is 30 percent and SK Ltd. does not make any investment, if it yields less than 12 percent. Advise SK ltd. whether the existing machine should be replaced or not. PV Factors @12% are:

Year	1	2	3	4	5
PVF	0.893	0.797	0.712	0.636	0.567

[**Sol.** ₹3,28,965]

33. SK Ltd. is considering replacing a manually operated old machine with a fully automatic new machine. The old machine had been fully depreciated for tax purpose but has a book value of ₹2,40,000 on 31st March, 2021. The machine has begun causing problems with breakdowns and it cannot fetch more than ₹30,000 if sold in the market at present. It will have no realizable value after 10 years. The company has been offered ₹1,00,000 for the old machine as a trade in on the new machine which has a price (before allowance for trade in) of ₹4,50,000. The expected life of new machine is 10 years with salvage value of ₹35,000.

Further the company follows straight line depreciation method but for tax purpose, written down value method depreciation @7.5%is allowed taking that this is the only machine in the block of assets.

Given below are the expected sales and costs from both old and new machine:

	Old Machine (₹)	New Machine (₹)
Sales	8,10,000	8,10,000
Material cost	1,80,000	1,26,250
Labour cost	1,35,000	1,10,000
Variable overhead	56,250	47,500
Fixed overhead	90,000	97,500
Depreciation	24,000	41,500
PBT	3,24,750	3,87,250
Tax @ 30%	97,425	1,16,175
PAT	2,27,325	2,71,075

From the above information, analyse whether the old machine should be replaced or not if required rate of return is 10%? Ignore capital gain tax. **[SM, RTP Dec 2021]**

PF Factors at 10%:

Year	1	2	3	4	5	6	7	8	9	10
PVF	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386

[**Sol.** ₹44,612.44]

34. SK Ltd. is presently all equity financed. The directors of the company have been evaluating investment in a project which will required ₹270 lakhs capital expenditure on new machinery. They expect the capital investment to provide annual cash flows of ₹42 lakhs indefinitely which is net of all tax adjustments. The discount rate which it applies to such investment decisions is 14% net.

The directors of the company believe that the current capital structure fails to take advantage of tax benefits of debt and propose to finance the new project with undated perpetual debt secured on the company's assets. The company intends to issue sufficient debt to cover the cost of capital expenditure and the after tax cost of issue.

The current annual gross rate of interest required by the market on corporate undated debt of similar risk is 10%. The after tax costs of issue are expected to be ₹10 lakhs. Company's tax rate is 30%.

You are required to:

(*a*) Calculate the adjusted present value of the investment,

(*b*) Calculate the adjusted discount rate and

(*c*) Explain the circumstances under which the adjusted discount rate may be used to evaluate the future investments.

[**Sol.** (*i*) ₹104 lakh; (*ii*) 8.8%]

PRACTICE QUESTIONS

35. SK ltd. is a small company that is currently analysing capital expenditure proposals for the purchase of equipment; the company uses the net present value technique to evaluate projects. The capital budget is limited to ₹5,00,000 which SK Ltd. believes is the maximum capital it can raise. The initial investment and projected net cash flows for each project are shown below. The cost of capital of SK Ltd. is 12%. You are required to compute the NPV of the different projects.

(Amount in ₹)

	Project A	Project B	Project C	Project D
Initial Investment	2,00,000	1,90,000	2,50,000	2,10,000
Project Cash Inflows				
Year 1	50,000	40,000	75,000	75,000
Year 2	50,000	50,000	75,000	75,000
Year 3	50,000	70,000	60,000	60,000
Year 4	50,000	75,000	80,000	40,000
Year 5	50,000	75,000	1,00,000	20,000

[**Sol.** NPV = (–) ₹19,750; ₹25,635; ₹27,050; (–)₹3,750]

36. A company is evaluating a project that requires initial investment of ₹60 lakhs in fixed assets and ₹12 lakhs towards additional working capital.

The project is expected to increase annual real cash inflow before taxes by ₹24,00,000 during its life. The fixed assets would have zero residual value at the end of life of 5 years. The company follows straight line method of depreciation which is expected for tax purposes also. Inflation is expected to be 6% per year. For evaluating similar projects, the company uses discounting rate of 12% in real terms. Company's tax rate is 30%. **[May 2018]**

Advise whether the company should accept the project, by calculating NPV in real terms.

PVIF (12%, 5 years)		PVIF (6%, 5 years)	
Year 1	0.893	Year 1	0.943
Year 2	0.797	Year 2	0.890
Year 3	0.712	Year 3	0.840
Year 4	0.636	Year 4	0.792
Year 5	0.567	Year 5	0.747

[**Sol.** NPV = ₹8,34,600]

37. AT Limited is considering three projects A, B and C. The cash flows associated with the projects are given below:

Cash flows associated with the Three Projects (₹)

Project	C_0	C_1	C_2	C_3	C_4
A	(10,000)	2,000	2,000	6,000	0
B	(2,000)	0	2,000	4,000	6,000
C	(10,000)	2,000	2,000	6,000	10,000

You are required to:

(*a*) Calculate the payback period of each of the three projects.

(*b*) If the cut-off period is two years, then which projects should be accepted?

(*c*) Projects with positive NPVs if the opportunity cost of capital is 10%.

(*d*) "Payback gives too much weight to cash flows that occur after the cut-off date" True of false?

(*e*) "If a firm used a single cutoff period for all projects, it is likely to accept too many short-lived projects." True or false? **[May 2019]**

PV Factor @ 10%

Year	0	1	2	3	4	5
P.V.	1	0.909	0.826	0.751	0.683	0.621

[**Sol.** (*a*) 3 years; 2 years; 3 years; (*b*) Project B; (*c*) (-)₹2,024; ₹6,754; ₹4,806; (*d*) False; (*e*) True]

38. CK Ltd. is planning to buy a new machine. Details of which are as follows:

Cost of the Machine at the commencement	₹2,50,000
Economic Life of the Machine	8 years
Residual Value	Nil
Annual Production Capacity of the machine	1,00,000 units
Estimated Selling Price per unit	₹6
Estimated annual fixed cost (excluding depreciation)	₹1,00,000
Estimated variable cost per unit (excluding depreciation)	₹3
Advertisement expenses in 1st year in addition of annual fixed cost	₹20,000
Maintenance expenses in 5th year in addition of annual fixed cost	₹30,000
Cost of capital	12%
Ignore tax	

Analyze the above mentioned proposal using the Net Present Value Method and advice. **[Nov 2020]**

PV Factor at 12% are as under:

Year	1	2	3	4	5	6	7	8
PV Factor	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404

[**Sol.** NPV = ₹7,08,730]

39. PD Ltd. an existing company, is planning to introduce a new product with projected life of 8 years. Project cost will be ₹2,40,00,000. At the end of 8 years no residual value will be realized. Working capital of ₹30,00,000 will be needed. The 100% capacity of the project is 2,00,000 units p.a. but the Production and Sales Volume is expected are as under:

Year	Number of Units
1	60,000 units
2	80,000 units
3 – 5	1,40,000 units
6 – 8	1,20,000 units

Other information:

(*i*) Selling price per unit ₹200

(*ii*) Variable cost is 40% of sales

(*iii*) Fixed cost p.a. ₹30,00,000

(*iv*) In addition to this advertisement expenditure will have to be incurred as under:

Year	1	2	3 – 5	6 - 8
Expenditure (₹)	50,00,000	25,00,000	10,00,000	5,00,000

(*v*) Income tax is 25%

(*vi*) Straight line method of depreciation is permissible for tax purpose

(*vii*) Cost of capital is 10%

(*viii*) Assume that loss cannot be carried forward. **[Nov 2018]**

Present Value Table

Year	1	2	3	4	5	6	7	8
PVF @ 10%	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467

[**Sol.** NPV = ₹1,18,82,700]

40. SK Hospital is considering to purchase a machine for medical projectional radiography which is price at ₹2,00,000. The projected life of the machine is 8 years and has an expected salvage value of ₹18,000 at the end of 8th year. The annual operating cost of the machine is ₹22,500. It is expected to generate revenues of ₹1,20,000 per year for eight years. Presently, the hospital is outsourcing the radiography work to its neighbour Test Center and is earning commission income of ₹36,000 per annum, net of taxes.

Required to analyse whether it would be profitable for the hospital to purchase the machine? Give your recommendation under:

(*i*) Net Present Value method

(*ii*) Profitability Index method **[SM, Similar RTP Nov 2022]**

Consider tax @30%. PV factors at 10% are given below:

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467

[**Sol.** (*i*) ₹16,832.06; (*ii*) 1.084]

41. A hospital is considering to purchase a diagnostic machine costing ₹80,000. The projected life of the machine is 8 years and has an expected salvage value of ₹6,000 at the end of 8 years. The annual operating cost of the machine is ₹7,500. It is expected to generate revenues of ₹40,000 per year for eight years. Presently, the hospital is outsourcing the diagnostic work and is earning commission income of ₹12,000 per annum. Consider tax rate of 30% Discounting Rate as 10%.

Advise: Whether it would be profitable for the hospital to purchase the machine?

Give your recommendation as per Net Present Value method and Present Value Index method under below mentioned two situations:

(*i*) If Commission income of ₹12,000 p.a. is before taxes.

(*ii*) If Commission income of ₹12,000 p.a. is net of taxes. **[Nov 2022]**

[**Sol.** (*i*) ₹14,146.76; 1.18; (*ii*) (–)₹5,055.64; 0.94]

42. SK Ltd. is a News broadcasting channel having its broadcasting Centre in Mumbai. There are total 200 employees in the organisation including top management. As a part of employee benefit expenses, the company serves tea or coffee to its employees, which is outsourced from a third party. The company offers tea or coffee three times a day to each of its employees. 120 employees prefer tea all three times, 40 employees prefer coffee all three times and remaining prefer tea only once in a day. The third party charges ₹10 for each cup of tea and ₹15 for each cup of coffee. The company works for 200 days in a year.

Looking at the substantial amount of expenditure on tea and coffee, the finance department has proposed to the management on installation of a master tea and coffee vending machine which will cost ₹10,00,000 with a useful life of five years. Upon purchasing the machine, the company will have to enter into an annual maintenance contract with the vendor, which will require a payment of ₹75,000 every year. The machine would require electricity consumption of 500 units p.m. and current incremental cost of electricity for the company is ₹12 per unit. Apart from these running costs, the company will have to incur the following consumables expenditure also:

(*a*) Packets of coffee beans at a cost of ₹90 per packet

(*b*) Packet of tea powder at a cost of ₹70 per packet

(*c*) Sugar at a cost of ₹50 per kg

(*d*) Milk at a cost of ₹50 per litre

(*e*) Paper cup at a cost of 20 paise per cup.

Each packet of coffee beans would produce 200 cups of coffee and same goes for tea powder packet. Each cup of tea or coffee would consist of 10g of sugar on an average and 100ml of milk.

The company anticipates that due to ready availability of tea and coffee through vending machines its employees would end up consuming more tea and coffee.

It estimates that the consumption will increase by on an average 20% for all class of employees. Also, the paper cups consumption will be 10% more than the actual cups swerved due to leakages in them.

The company is in the 25% tax bracket and has a current cost of capital at 12% per annum. Straight line method of depreciation is allowed for the purpose of taxation. You as a financial consultant is required to advise on the feasibility of acquiring the vending machine.

PV factors @12%:

Year	1	2	3	4	5
PVF	0.8929	0.7972	0.7118	0.6355	0.5674

[Sol. (–) ₹1,36,874]

43. A company wants to buy a machine, and two different models namely A and B are available. Following further particulars are available:

Particulars	Machine – A	Machine – B
Original Cost (₹)	8,00,000	6,00,000
Estimated Life in years	4	4
Salvage Value (₹)	0	0

The company provides depreciation under straight line method. Income tax rate applicable is 30%.

The present value of ₹1 at 12% discounting factor and net profit before depreciation and tax are as under:

Year	Net Profit Before Depreciation and tax		PV Factor
	Machine – A (₹)	Machine – B (₹)	
1	2,30,000	1,75,000	0.893
2	2,40,000	2,60,000	0.797
3	2,20,000	3,20,000	0.712
4	5,60,000	1,50,000	0.636

Calculate:

(1) NPV (Net Present Value)

(2) Discounted pay-back period

(3) PI (Profitability Index)

Suggest: Purchase of which is more beneficial under Discounted pay-back period method, NPV method and PI method. **[Jan 2021]**

[Sol. (1) ₹18,909; ₹17,909; (2) 3.93 years; 3.82 years; (3) 1.024; 1.029]

44. A company has ₹1,00,000 available for investment and has identified the following four investments in which to invest.

Project	Investment (₹)	NPV (₹)
C	40,000	20,000
D	1,00,000	35,000
E	50,000	24,000
F	60,000	18,000

You are required to optimize the returns from a package of projects within the capital spending limit if:

(*a*) The projects are independent of each other and are divisible

(*b*) The projects are not divisible **[Nov 2019]**

[**Sol.** (*a*) C, E & D; NPV = ₹47,500; (*b*) C & E; NPV = ₹44,000]

45. SK Ltd. is evaluating a project involving an outlay of ₹10,00,000 resulting in an annual cash inflow of ₹2,50,000 for 6 years. Assuming salvage value of the project is zero; determine the IRR of the project.

[**Sol.** 12.978%]

46. Calculate the internal rate of return of an investment of ₹1,36,000 which yields the following cash inflows:

Year	Cash Inflows (in ₹)
1	30,000
2	40,000
3	60,000
4	30,000
5	20,000

You may use following discount rates:

Year	1	2	3	4	5
PVF @ 10%	0.909	0.826	0.751	0.683	0.621
PVF @ 12%	0.893	0.797	0.712	0.636	0.567

[**Sol.** 10.704%]

47. Suppose there are two Project A and Project B are under consideration. The cash flows associated with these projects are as follows:

Year	Project A	Project B
0	(1,00,000)	(3,00,000)
1	50,000	1,40,000
2	60,000	1,90,000
3	40,000	1,00,000

Assuming cost of capital equal to 10%, identify which project should be accepted as per NPV Method and IRR Method.

Year	1	2	3
PVF @ 10%	0.909	0.826	0.751
PVF @ 20%	0.833	0.694	0.579

[**Sol.** NPV – A = ₹25,050; B = ₹59,300; IRR – A = 24.26%; B = 21.48%]

48. Suppose SK Ltd. is considering two projects X and Y for investment. The cash flows associated with these projects are as follows:

Year	Project X (₹)	Project Y (₹)
0	(2,50,000)	(3,00,000)
1	2,00,000	50,000
2	1,00,000	1,00,000
3	50,000	3,00,000

Assuming cost of capital be 10%, identify which project should be accepted as per NPV Method and IRR Method.

Year	1	2	3
PVF @ 10%	0.909	0.826	0.751
PVF @ 20%	0.833	0.694	0.579

[Sol. NPV – A = ₹51,950; B = ₹53,350; IRR – A = 24.87%; B = 17.60%]

49. Suppose SK Ltd. is considering two projects A and B for investment. The cash flows associated with these projects are as follows:

Year	Project A (₹)	Project B (₹)
0	(5,00,000)	(5,00,000)
1	7,50,000	2,00,000
2	0	2,00,000
3	0	7,00,000

Assuming cost of capital be 12%, identify which project should be accepted as per NPV Method and IRR Method.

Year	1	2	3
PVF @ 12%	0.893	0.797	0.712
PVF @ 50%	0.677	0.444	0.296

[**Sol.** NPV – A = ₹1,69,750; B = ₹3,36,400; IRR – A = 50%; B = 43.07%]

50. SK Company is considering the following investment projects:

	Cash Flows (₹)			
Projects	C_0	C_1	C_2	C_3
A	–10,000	+10,000		
B	–10,000	+7,500	+7,500	
C	–10,000	+2,000	+4,000	+12,000
D	–10,000	+10,000	+3,000	+3,000

(*a*) Analyse and rank the projects according to each of the following methods: (*i*) Payback; (*ii*) ARR, (*iii*) IRR and (*iv*) NPV, assuming discount rates of 10 and 30 percent.

(*b*) Assuming the projects are independent, which one should be accepted? If the projects are mutually exclusive, identify which project is the best?

[**Sol.** (*a*) (*i*) 1 year; 1.33 year; 2.33 year; 1 year; (*ii*) 0; 50%; 53%; 40%; (*iii*) 0%; 32%; 26.5%; 37.6%; (*iv*) (–)₹910; ₹3,013; ₹4.134; ₹3,821]

51. The expected cash flows of three projects are given below. The cost of capital is 10 percent.

(*a*) Calculate the payback period, net present value, internal rate of return and accounting rate of return of each project.

(*b*) Identify the rankings of the projects by each of the four methods.

(Figures in '000)

Period	Project A (₹)	Project B (₹)	Project C (₹)
0	(5,000)	(5,000)	(5,000)
1	900	700	2,000
2	900	800	2,000
3	900	900	2,000
4	900	1,000	1,000
5	900	1,100	

Period	Project A (₹)	Project B (₹)	Project C (₹)
6	900	1,200	
7	900	1,300	
8	900	1,400	
9	900	1,500	
10	900	1,600	

[Sol. (*a*) PBP = 5.56 year; 5.42 years; 2.5 years; NPV = ₹530.5; ₹655; IRR = 12.42%; 15.94%; 16.52%; ARR = 16%; 26%; 20%]

52. A company is considering the proposal of taking up a new project which requires an investment of ₹800 lakh on machinery and other assets. The project is expected to yield the following earnings (before depreciation and taxes) over the next five years:

Year	Earnings (₹in lakhs)
1	320
2	320
3	360
4	360
5	300

The cost of raising the additional capital is 12% and assets have to be depreciated at 20% on Written Down Value basis. The scrap value at the end of the five year's period may be taken as zero. Income-tax applicable to the company is 40%. You are required to calculate the net present value of the project and advise the management to take appropriate decision. Also calculate the Internal Rate of Return of the Project.

Note: Present value of ₹1 at different rates of interest are as follows:

Year	10%	12%	14%	16%	20%
1	91%	0.89	0.88	0.86	0.83
2	0.83	0.8	0.77	0.74	0.69
3	0.75	0.71	0.67	0.64	0.58
4	0.68	0.64	0.59	0.55	0.48
5	0.62	0.57	0.52	0.48	0.40

[**Sol.** NPV = ₹141.94 lakhs; IRR = 18.64%]

53. SK Company is considering a new product line to supplement its range of products. It is anticipated that the new product line will involve cash investments of ₹7,00,000 at time 0 and ₹10,00,000 in year 1. After-tax cash inflows of ₹2,50,000 are expected in year 2, ₹3,00,000 in year 3, ₹3,50,000 in year 4 and ₹4,00,000 each year thereafter through year 10. Although the product line might be viable after year 10, the company prefers to be conservative and end all calculations at that time.

(*a*) If the required rate of return is 15 percent, compute net present value of the project? Is it acceptable?

(*b*) Analyse what would be the case if the required rate of return were 10 percent?

(*c*) Calculate its internal rate of return?

(*d*) Compute the project's payback period?

[Sol. (*a*) (–)₹1,18,200; (*b*) ₹2,51,450; (*c*) 13.40%; (*d*) 6 years]

54. SK Ltd. is considering purchasing of new plant worth ₹80,00,000. The expected net cash flows after taxes and before depreciation are as follows:

Year	Net Cash Flows (₹)
1	14,00,000
2	14,00,000
3	14,00,000
4	14,00,000
5	14,00,000
6	16,00,000
7	20,00,000
8	30,00,000
9	20,00,000
10	8,00,000

The rate of cost of capital is 10%. You are required to calculate:

(*i*) Pay back period

(*ii*) Net present value at 10 discount factor

(*iii*) Profitability index at 10 discount factor

(*iv*) Internal rate of return with the help of 10% and 15% discount factor

The following present value table is given for you:

Year	Present Value of ₹1 at 10% discount rate	Present Value of ₹1 at 15% discount rate
1	0.909	0.87
2	0.826	0.756
3	0.751	0.658
4	0.683	0.572
5	0.621	0.497
6	0.564	0.432
7	0.513	0.376
8	0.467	0.327
9	0.424	0.284
10	0.386	0.247

[Sol. (*i*) 5.625 years;(*ii*) ₹17,92,200; (*iii*) 1.224; (*iv*) 14.7%]

55. SK Ltd. wants to replace its old machine with a new automatic machine. Two models A and B are available at the same cost of ₹5 lakhs each. Salvage value of the old machine is ₹1 lakhs. The utilities of the existing machine can be used if the company purchases A. Additional cost of utilities

to be purchased in that case are ₹1 lakh. If the company purchases B then all the existing utilities will have to be replaced with new utilities costing ₹2 lakhs. The salvage value of the old utilities will be ₹0.20 lakhs. The earnings after taxation are expected to be:

Year	Cash in Flows of		P.F. Factor @ 15%
	A (₹)	B (₹)	
1	1,00,000	2,00,000	0.870
2	1,50,000	2,10,000	0.756
3	1,80,000	1,80,000	0.658
4	2,00,000	1,70,000	0.572
5	1,70,000	40,000	0.497
Salvage value at the end of year 5	50,000	60,000	

The targeted return on capital is 15%. You are required to (i) compute for the two machines separately, net present value, discounted payback period and desirability factor and (ii) state which of the machines is to be selected?

[**Sol.** (*i*) NPV = ₹42,580; ₹18,140; DPBP = 4.61 years; 4.63 years; PI = 1.08; 1.03]

56. The General Manager of Merry Ltd. is considering the replacement of five-year old equipment. The company has to incur excessive maintenance cost of the equipment. The equipment has zero written down value. It can be modernized at a cost of ₹1,40,000 enhancing its economic life to 5 years. The equipment could be sold for ₹30,000 after 5 years. The modernization would help in material handling and in reducing labour, maintenance & repairs costs.

The company has another alternative to buy a new machine at a cost of ₹3,50,000 with an economic life of 5 years and salvage value of ₹60,000. The new machine is expected to be more efficient in reducing costs of material handling, labour, maintenance & repairs etc.

The annual cost are as follows:

	Existing Equipment (₹)	Modernization (₹)	New Machine (₹)
Wages & Salaries	45,000	35,500	15,000
Supervision	20,000	10,000	7,000
Maintenance	25,000	5,000	2,500
Power	30,000	20,000	15,000
	1,20,000	70,500	39,500

Assuming tax rate of 50% and required rate of return of 10%, should the company modernize the equipment or buy a new machine? **[RTP May 2021]**

PV factor at 10% are as follows:

Year	1	2	3	4	5
PV Factor	0.909	0.826	0.751	0.683	0.621

[**Sol.** NPV = ₹14,123; (-)₹50,282]

57. Four years ago, Z Ltd. had purchased a machine of ₹4,80,000 having estimated useful life of 8 years with zero salvage value. Depreciation is charged using SLM method over the useful life. The company want to replace this machine with a new machine. Details of new machine are as below:

- Cost of new machine is ₹12,00,000, Vendor of this machine is agreed to take old machine at a value of ₹2,40,000. Cost of dismantling and removal of old machine will be ₹40,000. 80% of net purchase price will be paid on spot and remaining will be paid at the end of one year.
- Depreciation will be charged @ 20% p.a. under WDV method.
- Estimated useful life of new machine is four years and it has salvage value of ₹1,00,000 at the end of year four.
- Incremental annual sales revenue is ₹12,25,000.
- Contribution margin is 50%.
- Incremental indirect cost (excluding depreciation) is ₹1,18,750 per year.
- Additional working capital of ₹2,50,000 is required at the beginning of year and ₹3,00,000 at the beginning of year three. Working capital at the end of year four will be nil.
- Tax rate is 30%.
- Ignore tax on capital gain.

Z Ltd. will not make any additional investment, if it yields less than 12%.

Advice, whether existing machine should be replaced or not.

Year	1	2	3	4	5
PVIF0.12, t	0.893	0.797	0.712	0.636	0.567

[Sol. Incremental NPV = ₹79,739.47]

58. SK Ltd. is planning to invest in a machinery that would cost ₹1,00,000 at the beginning of year 1. Net cash inflows from operations have been estimated at ₹36,000 per annum for 3 years. The company has two options for smooth functioning of the machinery – one is service and another is replacement of parts. If the company opts to service a part of the machinery at the end of year 1 at ₹20,000, in such a case, the scrap value at the end of year 3 will be ₹25,000. However, if the company decides not to service the part, then it will have to be replaced at the end of year 2 at ₹30,800. And in this case, the machinery will work for the 4th year also and get operational cash inflow of ₹36,000 for the 4th year. It will have to be scrapped at the end of year 4 at ₹18,000.

Assuming cost of capital at 10% and ignoring taxes, determine the purchase of this machinery based on the net present value of its cash flows?

If the supplier gives a discount of ₹10,000 for purchase, what would be your decision?

Note: The PV Factors at 10% are:

Year	0	1	2	3	4	5	6
PV Factor	1	0.9091	0.8264	0.7513	0.6830	0.6290	0.5645

[**Sol.** NPV = (–)₹9,874.7; NPV = ₹953.68]

59. An existing company has a machine which has been in operation for two years, its estimated remaining useful life is 4 years with no residual value in the end. Its current market value is ₹3 lakhs. The management is considering a proposal to purchase an improved model of a machine gives increase output. The details are as under:

Particulars	Existing Machine	New Machine
Purchase Price	₹6,00,000	₹10,00,000
Estimated Life	6 years	4 years
Residual Value	0	0
Annual Operating days	300	300
Operating hours per day	6	6
Selling price per unit	₹10	₹10
Material cost per unit	₹2	₹2
Output per hour in units	20	40
Labour cost per hour	₹20	₹30
Fixed overhead per annum excluding depreciation	₹1,00,000	₹60,000
Working Capital	₹1,00,000	₹2,00,000
Income-tax rate	30%	30%

Assuming that - cost of capital is 10% and the company uses written down value of depreciation @ 20% and it has several machines in 20% block. **[July 2021]**

Advice the management on the Replacement of Machine as per the NPV method. The discounting factors table given below:

Discounting Factors	Year 1	Year 2	Year 3	Year 4
10%	0.909	0.826	0.751	0.683

[**Sol.** NPV = ₹56,779]

60. SK Ltd. is contemplating whether to replace an existing machine or to spend money on overhauling it. SK Ltd. currently pays no taxes. The replacement machine costs ₹90,000 now and requires maintenance of ₹10,000 at the end of every year for eight years. At the end of eight years it would have a salvage value of ₹20,000 and would be sold. The existing machine requires increasing amounts of maintenance each year and its salvage value falls each year as follows:

Year	Maintenance (₹)	Salvage (₹)
Present	0	40,000
1	10,000	25,000
2	20,000	15,000
3	30,000	10,000
4	40,000	0

The opportunity cost of capital for SK Ltd. is 15%. When should the company replace the machine? (Note: Present value of an annuity of ₹1 per period for 8 years at interest rate of 15%: 4.4873l present value of ₹1 to be received after 8 years at interest rate of 15%: 0.3269)

[SM, Similar RTP May 2022]

[Sol. PV = ₹11,400; (-)₹11,832; (-)₹34,102; (-)₹55,799; (-)₹82,799]

SOLUTIONS

35. **Calculation of net present value:**

Period	PV factor	Project A (₹)	Project B (₹)	Project C (₹)	Project D (₹)
0	1.000	(2,00,000)	(1,90,000)	(2,50,000)	(2,10,000)
1	0.893	44,650	35,720	66,975	66,975
2	0.797	39,850	39,850	59,775	59,775
3	0.712	35,600	49,840	42,720	42,720
4	0.636	31,800	47,700	50,880	25,440
5	0.567	28,350	42,525	56,700	11,340
Net Present Value		(19,750)	25,635	27,050	(3,750)

36. **Statement of NPV**

Particulars	Time	PVF	Amount	Present Value
Cost of equipment	0	1	60,00,000	60,00,000
Working capital	0	1	12,00,000	12,00,000
			PVCO	**72,00,000**
Cash flows (w.n.-1)	1-5	3.605	24,60,000	73,54,200
Working capital realization	5	0.567	12,00,000	6,80,400
			PVCI	**80,34,600**
NPV (PVCI – PVCO)				**8,34,600**

It is recommended to accept the project in view of positive NPV.

Working Note – 1

Year	1
PBD (A)	24,00,000
Depreciation (60,00,000 ÷ 5)	12,00,000
PBT	12,00,000
Tax @ 30% (B)	3,60,000
Cash Inflow (A - B)	**20,40,000**

37.

Year	Project A		Project B		Project C	
	CF	Cumulative	CF	Cumulative	CF	Cumulative
1	2,000	2,000	0	0	2,000	2,000
2	2,000	4,000	2,000	2,000	2,000	4,000
3	6,000	10,000	4,000	6,000	6,000	10,000
4	–	–	6,000	12,000	10,000	20,000

(*a*) Payback period of Project A = 3 years

Payback period of Project B = 2 years

Payback period of Project C = 3 years

(*b*) Project B is the only acceptable project if cut-off period is 2 years.

(*c*) **Statement of NPV**

Year	PVF @10%	Project A		Project B		Project C	
		CF	PV	CF	PV	CF	PV
0	1	(10,000)	(10,000)	(2,000)	(2,000)	(10,000)	(10,000)
1	0.909	2,000	1,818	-	-	2,000	1,818
2	0.826	2,000	1,652	2,000	1,652	2,000	1,652
3	0.751	6,000	4,506	4,000	3,004	6,000	4,506
4	0.683	-	-	6,000	4,098	10,000	6,830
NPV			**(2,024)**		**6,754**		**4,806**

Project B and C have positive NPVs.

(*d*) Payback period doesn't give weightage to the cash flows after the cut off date so the statement given is false.

(*e*) The statement given is true. Payback period ignores all cash flows after the cut off date which means that future cash flows are not considered. Thus, payback period is biased towards short-term projects.

38. **Statement of Present Value of Cash Flows**

Particulars	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Units	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000
Contribution per unit (6–3)	3	3	3	3	3	3	3	3
Total Contribution	3,00,000	3,00,000	3,00,000	3,00,000	3,00,000	3,00,000	3,00,000	3,00,000
(–) Fixed Cost	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000
(–) Advert.	20,000	–	–	–	–	–	–	–
(–) Maint.	–	–	–	–	30,000	–	–	–
Profit Before Dep. or CF	1,80,000	2,00,000	2,00,000	2,00,000	1,70,000	2,00,000	2,00,000	2,00,000
PVF @ 12%	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404
Present Value	1,60,740	1,59,400	1,42,400	1,27,200	96,390	1,01,400	90,400	80,800

Total Present value of cash inflows = 9,58,730 (from above table)

NPV = PVCI – PVCO = 9,58,730 – 2,50,000 = ₹7,08,730

It is recommended to accept the proposal as it has positive NPV.

39. **Statement of NPV**

Particulars	Time	PVF	Amount	Present Value
Cost of equipment	0	1	2,40,00,000	2,40,00,000
Working capital	0	1	30,00,000	30,00,000
			PVCO	**2,70,00,000**
Incremental Cash flows (w.n.-1)	1	0.909	(8,00,000)	(7,27,200)
	2	0.826	38,25,000	31,59,450
	3-5	2.055	1,03,50,000	2,12,69,250
	6-8	1.544	89,25,000	1,37,80,200
Working capital realization	8	0.467	30,00,000	14,01,000
			PVCI	**3,88,82,700**
NPV (PVCI – PVCO)				**1,18,82,700**

It is recommended to accept the project in view of positive NPV.

Working Note – 1

Year	1	2	3 –5	6 –8
Sales (units)	60,000	80,000	1,40,000	1,20,000
Contribution @ ₹120 p.u.	72,00,000	96,00,000	1,68,00,000	1,44,00,000
Fixed Cost	30,00,000	30,00,000	30,00,000	30,00,000
Advertisement	50,00,000	25,00,000	10,00,000	5,00,000
PBD (A)	(8,00,000)	41,00,000	1,28,00,000	1,09,00,000
Depreciation	30,00,000	30,00,000	30,00,000	30,00,000
PBT	(38,00,000)	11,00,000	98,00,000	79,00,000
Tax @ 25% (B)	–	2,75,000	24,50,000	19,75,000
Cash Inflow (A – B)	**(8,00,000)**	**38,25,000**	**1,03,50,000**	**89,25,000**

40. **Determination of Cash inflows**

Particulars	(₹)
Sales Revenue	
Less: Operating Cost	22,500
	97,500
Less: Depreciation (₹2,00,000-₹18,000)/8	22,750
Net Income	74,750
Less: Tax @ 30%	22,425

Particulars	(₹)
Earnings after Tax (EAT)	52,325
Add: Depreciation	22,750
Cash inflow after tax per annum	75,075
Less: Loss of Commission Income	36,000
Net Cash inflow after tax per annum	39,075
In 8th Year :	
New Cash inflow after tax	39,075
Add: Salvage Value of Machine	18,000
Net Cash inflow in year 8	57,075

(*i*) Calculation of Net Present Value (NPV)

Year	CFAT (₹)	PV Factor @10%	Present Value of Cash inflows (₹)
1 to 7	39,075	4.867	1,90,178.03
8	57,075	0.467	26,654.03
			2,16,832.06
Less: Cash Outflows			2,00,000.00
NPV			16,832.06

(*ii*) Calculation of Profitability Index

$$\text{Profitability Index} = \frac{\text{Sum of discounted cash in flows}}{\text{Present value of cash out flows}} = \frac{2,16,832.06}{2,00,000} = 1.084$$

Advise: Since the net present value (NPV) is positive and profitability index is also greater than 1, the hospital may purchase the machine.

41. Analysis of Investment Decisions

Determination of Cash inflows	Situation-(i) Commission Income before taxes	Situation-(ii) Commission Income after taxes
Cash flow up-to 7th year:	40,000	40,000
Sales Revenue	(7,500)	(7,500)
Less: Operating Cost	32,500	32,500
	(9,250)	(9,250)
Less: Depreciation (80,000 – 6,000) ÷ 8	23,250	23,250
Net Income	(6,975)	(6,975)
Tax @ 30%	16,275	16,275
Earnings after Tax (EAT) Add: Depreciation	9,250	9,250
Cash inflow after tax per annum	25,525	25,525
Less: Loss of Commission Income	(8,400)	(12,000)

Determination of Cash inflows	Situation-(i) Commission Income before taxes	Situation-(ii) Commission Income after taxes
Net Cash inflow after tax per annum	17,125	13,525
In 8th Year.		
Net Cash inflow after tax	17,125	13,525
Add: Salvage Value of Machine	6,000	6,000
Net Cash inflow in year 8	**23,125**	**19,525**

Calculation of NPV and Profitability Index

	Particulars	PV factor @10%	Situation-(i) [Commission Income before taxes]	Situation-(ii) [Commission Income after taxes]
A	Present value of cash inflows (1^{st} to 7^{th} year)	4.867	83,347.38 (17,125 × 4,867)	65,826.18 (13,525 × 4.867)
B	Present value of cash inflow at 8^{th} year	0.467	10,799.38 (23,125 × 0.467)	9,118.18 (19,525 × 0.467)
C	PV of cash inflows	1.00	94,146.76	74,944.36
D	Less: Cash Outflow		(80,000)	(80,000)
E	**Net Present Value (NPV)**		**14,146.76**	**(5,055.64)**
F	**PI = (C ÷ D)**		**1.18**	**0.94**

Recommendation: The hospital may consider purchasing of diagnostic machine in situation (*i*) where commission income is 12,000 before tax as NPV is positive and PI is also greater than 1. Contrary to situation (*i*), in situation (*ii*) where the commission income is net of tax, the recommendation is reversed to not purchase the machine as NPV is negative and PI is also less than 1.

42. A. Computation of CFAT (Year 1 to 5)

Particulars		Amount (₹)
(*a*) Savings in existing Tea & Coffee charges (120 × 10 × 3) + (40 × 15 × 3) + (40 × 10 × 1) × 200 days		11,60,000
(*b*) AMC of machine		(75,000)
(*c*) Electricity charges	500×12×12	(72,000)
(*d*) Coffee Beans	(W.N.) 144×90	(12,960)
(*e*) Tea Powder	(W.N.) 480×70	(33,600)
(*f*) Sugar	(W.N.) 1248×50	(62,400)
(*g*) Milk	(W.N.) 12480×50	(6,24,000)
(*h*) Paper Cup	(W.N.) 1,37,280×0.2	(27,456)
(*i*) Depreciation	10,00,000/5	(2,00,000)

Particulars		Amount (₹)
Profit before Tax		52,584
(-) Tax @ 25%		(13,146)
Profit after Tax		39,438
Depreciation		2,00,000
CFAT		2,39,438

B. **Computation of NPV**

Year	Particulars	CF	PVF @ 12%	PV
0	Cost of machine	(10,00,00)	1	(10,00,000)
1-5	CFAT	2,39,438	3.6048	8,63,126
Net Present Value				(1,36,874)

Since NPV of the machine is negative, it should not be purchased.

Working Note:

Computation of Qty of consumable

No. of Tea Cups = (120 × 3 × 200 days) + (40 × 1 × 200 days) × 1.2 = 96,000

No. of Coffee cups = 40 × 3 × 200 days × 1.2 = 28,800

No. of coffee beans packet $= \frac{28,800}{200} = 144$

No. of Tea Powder Packets $= \frac{96,000}{200} = 480$

Qty of Sugar $= \frac{(96,000+28,800)6,000}{1,000g} = 1248kgs$

Qty of Milk litres $= \frac{(96,000+28,800)6,000}{1,000ml} = 12,480$

No. of paper cups = (96,000+28,800) × 1.1 = 1,37,280

43. **Statement of Cash flows and PV of Cash flows of Machine A**

Year	CFBT	Depreciation	PBT	Tax@30%	CFAT	PVF	PVCI
	A	B	C=A-B	D=C×30%	E=A-D	F	E×F
1	2,30,000	2,00,000	30,000	9,000	2,21,000	0.893	1,97,353
2	2,40,000	2,00,000	40,000	12,000	2,28,000	0.797	1,81,716
3	2,20,000	2,00,000	20,000	6,000	2,14,000	0.712	1,52,368
4	5,60,000	2,00,000	3,60,000	1,08,000	4,52,000	0.636	2,87,472
Total					**11,15,000**		**8,18,909**

Statement of Cash flows and PV of Cash flows of Machine B

Year	CFBT	Depreciation	PBT	Tax@30%	CFAT	PVF	PVCI
	A	B	C=A-B	D=C×30%	E=A-D	F	E×F
1	1,75,000	1,50,000	25,000	7,500	1,67,500	0.893	1,49,578
2	2,60,000	1,50,000	1,10,000	33,000	2,27,000	0.797	1,80,919
3	3,20,000	1,50,000	1,70,000	51,000	2,69,000	0.712	1,91,528
4	1,50,000	1,50,000	–	–	1,50,000	0.636	95,400
Total					**8,13,500**		**6,17,425**

(1) NPV of Machine A = PVCI – PVCO = 8,18,909 – 8,00,000 = ₹18,909

NPV of Machine B = PVCI – PVCO = 6,17,909 – 6,00,000 = ₹17,909

(2) Statement of Cumulative PVCI

	Year 1	Year 2	Year 3	Year 4
PVCI – Machine A	1,97,353	1,81,716	1,52,368	2,87,472
Cumulative PVCI – Machine A	1,97,353	3,79,069	5,31,437	8,16,909
PVCI – Machine B	1,49,578	1,80,919	1,91,528	95,400
Cumulative PVCI – Machine B	1,49,578	3,30,497	5,22,025	6,17,425

$$\text{Discounted Pay-back period of Machine A} = 3 + \frac{(8,00,00 - 5,31,437)}{2,87,472} = 3.93 \text{ years}$$

$$\text{Discounted Pay-back period of Machine B} = 3 + \frac{(6,00,00 - 5,22,025)}{95,400} = 3.82 \text{ years}$$

(3) $\text{Profitability Index of Machine A} = \frac{PVCI}{PVCO} = \frac{8,18,909}{8,00,000} = 1.024$

$\text{Profitability Index of Machine B} = \frac{PVCI}{PVCO} = \frac{6,17,425}{6,00,000} = 1.029$

Method	Recommendation
Discounted Pay-back period	Machine B as it has lower discounted pay-back period
NPV	Machine A as it has higher NPV
Profitability Index	Machine B as it has higher PI

44. (a) Computation of NPV per ₹1 of investment and Ranking of Projects

Project	Investment (₹)	NPV (₹)	NPV per ₹1 invested (₹)	Ranking
C	40,000	20,000	0.50	1
D	1,00,000	35,000	0.35	3

Project	Investment (₹)	NPV (₹)	NPV per ₹1 invested (₹)	Ranking
E	50,000	24,000	0.48	2
F	60,000	18,000	0.30	4

Calculation of Package of Projects

Project	Investment (₹)	NPV (₹)
C	40,000	20,000
E	50,000	24,000
D (1/10th of Project)	10,000	3,500
Total	**1,00,000**	**47,500**

The company would be well advised to invest in Project C, E and D (1/10th) and reject Project F to optimize return within the amount of ₹1,00,000 available for investment.

(*b*) Calculation of Package of Projects

Package of Project	Investment (₹)	NPV (₹)
C and E	90 000 (40,000 + 50,000)	44,000 (20,000 + 24,000)
C and F	1,00,000 (40,000 + 60,000)	38,000 (20,000 + 18,000)
Only D	1,00,000	35,000

The company would be well advised to invest in Projects C and E to optimize return within the amount of ₹1,00,000 available for investment.

45. First of all, we shall find an approximation of the payback period: $= \frac{10,00,000}{2,50,000} = 4$

Now, we shall search this figure in the PVAF table corresponding to 6-year row. The value 4 lies between values 4.111 and 3.998 , correspondingly discounting rates are and respectively NPV @ 12% and 13% is:

$NPV_{12\%} = (10,00,000) + 4.111 \times 2,50,000 = +27,750$

$NPV_{13\%} = (10,00,000) + 3.998 \times 2,50,000 = -500$

The internal rate of return is, thus, more than 12% but less than 13%. The exact rate can be obtained by interpolation:

$$IRR = 12\% + \frac{27,750}{27,750 - (-500)} \times (13\% - 12\%) = 12\% + \frac{27,750}{28,250} = 12.978\%$$

IRR $= 2.978\%$

46. Let us discount cash flows by 10%.

Year	Cash Inflows(₹)	Discounting factor at 10%	Present Value (₹)
1	30,000	0.909	27,270
2	40,000	0.826	33,040
3	60,000	0.751	45,060

Year	Cash Inflows(₹)	Discounting factor at 10%	Present Value (₹)
4	30,000	0.683	20,490
5	20,000	0.621	12,420
Total present value			1,38,280
Less: Initial Investment			1,36,000
NPV			+2,280

The NPV calculated @ 10% is positive. Therefore, a higher discount rate is suggested, say, 12%.

Year	Cash Inflows (₹)	Discounting factor at 12%	Present Value (₹)
1	30,000	0.893	26,790
2	40,000	0.797	31,880
3	60,000	0.712	42,720
4	30,000	0.636	19,080
5	20,000	0.567	11,340
Total present value			1,31,810
Less: Initial Investment			1,36,000
NPV			– 4,190

The internal rate of return is, thus, more than 10% but less than 12%. The exact rate can be obtained by interpolation:

$$IRR = \text{LR} + \frac{\text{NPV at LR}}{\text{NPV at LR} - \text{NPV at HR}} \times (\text{HR} - \text{LR}) = 10 + \frac{₹\ 2,280}{₹\ 2,280 - (-4,190)} \times (12 - 10)$$

$$= 10 + \frac{₹\ 2,280}{₹\ 6,470} \times (12 - 10) = 10 + 0.704 = 10.704\%$$

47. Net Present Value (NPV) of Projects

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @10%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
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
NPV				25,050	59,300

Internal Rate of Returns (IRR) of projects

Since by discounting cash flows at 10%, we are getting values very far from zero. Therefore, let us discount cash flows using 20% discounting rate.

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @20%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.833	41,650	1,16,620
2	60,000	1,90,000	0.694	41,640	1,31,860
3	40,000	1,00,000	0.579	23,160	57,900
NPV				6,450	6,380

Even by discounting cash flows at 20%, we are getting values far from zero. Therefore, let us discount cash flows using 25% discounting rate.

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @25%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.800	40,000	1,12,000
2	60,000	1,90,000	0.640	38,400	1,21,600
3	40,000	1,00,000	0.512	20,480	51,200
NPV				(1,120)	(15,200)

The internal rate of return is, thus, more than 20% but less than 25%. The exact rate can be obtained by interpolation:

$$IRR_A = 20\% + \frac{6,450}{6,450-(1,120)} \times (25\% - 20\%) = 20\% + \left(\frac{6,450}{7,570} \times 5\%\right) = 24.26\%$$

$$IRR_B = 20\% + \frac{6,380}{6,380-(15,200)} \times (25\% - 20\%) = 20\% + \left(\frac{6,380}{21,580} \times 5\%\right) = 21.48\%$$

Overall Position

	Project A	Project B
NPV @ 10%	₹25,050	₹59,300
IRR	24.26%	21.48%

Thus, there is contradiction in ranking by two methods.

48. Net Present Value of Projects

Year	Cash Inflows of Project X (₹)	Cash Inflows of Project Y (₹)	Present Value Factor @ 10%	PV of Project X (₹)	PV of Project Y (₹)
0	(2,50,000)	(3,00,000)	1.000	(2,50,000)	(3,00,000)
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

Year	Cash Inflows of Project X (₹)	Cash Inflows of Project Y (₹)	Present Value Factor @ 10%	PV of Project X (₹)	PV of Project Y (₹)
3	50,000	3,00,000	0.751	37,550	2,25,300
NPV				51,950	53,350

Internal Rate of Returns of projects

Since, by discounting cash flows at 10%, we are getting values far from zero. Therefore, let us discount cash flows using 20% discounting rate.

Year	Cash Inflows of Project X (₹)	Cash Inflows of Project Y (₹)	Present Value Factor @ 10%	PV of Project X (₹)	PV of Project Y (₹)
0	(2,50,000)	(3,00,000)	1.000	(2,50,000)	(3,00,000)
1	2,00,000	50,000	0.833	1,66,600	41,650
2	1,00,000	1,00,000	0.694	69,400	69,400
3	50,000	3,00,000	0.579	28,950	1,73,700
NPV				14,950	(15,250)

Since, by discounting cash flows at 20% we are getting that value of Project *X* is positive and value of Project *Y* is negative. Therefore, let us discount cash flows of Project *X* using 25% discounting rate and Project *Y* using discount rate of 15%.

Year	Cash Inflows of Project X (₹)	Present Value Factor @ 25%	PV of Project X (₹)	Cash Inflows of Project Y (₹)	Present Value Factor @ 15%	PV of Project Y (₹)
0	(2,50,000)	1.000	(2,50,000)	(3,00,000)	1.000	(3,00,000)
1	2,00,000	0.800	1,60,000	50,000	0.870	43,500
2	1,00,000	0.640	64,000	1,00,000	0.756	75,600
3	50,000	0.512	25,600	3,00,000	0.658	1,97,400
NPV			(400)			16,500

The internal rate can be obtained by interpolation:

$$\text{IRRx} = 20\% + \frac{14,950}{14,950-(400)} \times (25\% - 20\%) = 20\% + \left(\frac{14,950}{15,350} \times 5\%\right) = 24.87\%$$

$$IRR_B = 15\% + \frac{16,500}{16,500-(15,250)} \times (20\% - 15\%) = 15\% + \left(\frac{16,500}{31,750} \times 5\%\right) = 17.60\%$$

Overall Position

	Project A	Project B
NPV @ 10%	₹51,950	₹53,350
IRR	24.87%	17.60%

Thus, there is contradiction in ranking by two methods.

49. Net Present Value of Projects

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @ 12%	PV of Project A (₹)	PV of Project B (₹)
0	(5,00,000)	(5,00,000)	1.000	(5,00,000)	(5,00,000)
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
NPV				1,69,750	3,36,400

Internal Rate of Returns of projects

Let us discount cash flows using 50% discounting rate.

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B(₹)	Present Value Factor @ 12%	PV of Project A (₹)	PV of Project B (₹)
0	(5,00,000)	(5,00,000)	1.000	(5,00,000)	(5,00,000)
1	7,50,000	2,00,000	0.667	5,00,250	1,33,400
2	0	2,00,000	0.444	0	88,800
3	0	7,00,000	0.296	0	2,07,200
NPV				250	(70,600)

Since, IRR of project *A* shall be 50% as NPV is very small. Further, by discounting cash flows at 50%, we are getting NPV of Project *B* negative. Therefore, let us discount cash flows of Project *B* using 15% discounting rate.

Year	Cash Inflows of Project B (₹)	Present Value Factor @ 15%	PV of Project B (₹)
0	(5,00,000)	1.000	(5,00,000)
1	2,00,000	0.870	1,74,000
2	2,00,000	0.756	1,51,200
3	7,00,000	0.658	4,60,600
NPV			2,85,800

The internal rate can be obtained by interpolation:

$$IRR_B = 15\% + \frac{2,85,800}{2,85,800 - (70,600)} \times (50\% - 15\%)$$

$$= 15\% + \left(\frac{2,85,800}{3,56,400} \times 35\% \right) = 43.07\%$$

Overall Position

	Project A	Project B
NPV @ 12%	₹1,69,750	₹3,36,400
IRR	50.00%	43.07%

Thus, there is contradiction in ranking by two methods.

50. (*i*) Payback Period

Project A: ₹10,000/₹10,000 = 1 year

Project B: ₹10,000/₹7,500 = 1.33 years

Project C: $2 \text{ years} + \frac{₹\ 10,000 - ₹\ 6,000}{₹\ 12,000} = 2\frac{1}{3}$ years

Project D: 1 year

(*ii*) ARR (Figures in ₹)

$$\text{Project A}: \frac{(10,000 - 10,000)1/2}{(10,000)1/2} = 0$$

$$\text{Project B}: \frac{(15,000 - 10,000)1/2}{(10,000)1/2} = \frac{2,500}{5,000} = 50\%$$

$$\text{Project C}: \frac{(18,000 - 10,000)1/3}{(10,000)1/2} = \frac{2,667}{5,000} = 53\%$$

$$\text{Project D}: \frac{(16,000 - 10,000)1/3}{(10,000)1/2} = \frac{2,000}{5,000} = 40\%$$

Note: This net cash proceed includes recovery of investment also. Therefore, net cash earnings are found by deducting initial investment.

(*iii*) IRR

Project A:	The net cash proceeds in year 1 are just equal to investment. Therefore, *r* = 0%.
Project B:	This project produces an annuity of ₹7,500 for two years. Therefore, the required PVAF is: ₹10,000/₹7,500 = 1.33. This factor is found under 32% column. Therefore, *r* = 32%
Project C:	Since cash flows are uneven, the trial and error method will be followed. Using 20% rate of discount, the NPV is + ₹1,389. At 30% rate of discount, the NPV is - ₹633. The true rate of return should be less than 30%. At 27% rate of discount, it is found that the NPV is - ₹86 and + ₹105 at 26%. Through interpolation, we find *r* = 26.5%
Project D:	In this case also by using the trial and error method, it is found that at 37.6% rate of discount, NPV becomes almost zero. Therefore, *r* = 37.6%.

(*iv*) NPV

Project A:

at 10% $-10,000 + 10,000 \times 0.909 = -910$

at 30% $-10,000 + 10,000 \times 0.769 = -2,310$

Project B:

at 10% $-10,000 + 7,500(0.909 + 0.826) = +3,013$

at 30% $-10{,}000 + 7{,}500(0.769 + 0.592) = +208$

Project C:

at 10% $-10{,}000 + 2{,}000 \times 0.909 + 4{,}000 \times 0.826 + 12{,}000 \times 0.751 = +4{,}134$

at 30% $-10{,}000 + 2{,}000 \times 0.769 + 4{,}000 \times 0.592 + 12{,}000 \times 0.455 = -633$

Project D:

at 10% $-10{,}000 + 10{,}000 \times 0.909 + 3{,}000 \times (0.826 + 0.751) = +3{,}821$

at 30% $-10{,}000 + 10{,}000 \times 0.769 + 3{,}000 \times (0.592 + 0.455) = +831$

The projects are ranked as follows according to the various methods:

Projects	PBP	ARR	IRR	NPV (10%)	NPV (30%)
A	1	4	4	4	4
B	2	2	2	3	2
C	3	1	3	1	3
D	1	3	1	2	1

(*b*) Payback and ARR are theoretically unsound method for choosing between the investment projects. Between the two time-adjusted (DCF) investment criteria, NPV and IRR, NPV gives consistent results. If the projects are independent (and there is no capital rationing), either IRR or NPV can be used since the same set of projects will be accepted by any of the methods. In the present case, except Project *A* all the three projects should be accepted if the discount rate is 10%. Only Projects *B* and *D* should be undertaken if the discount rate is 30%.

If it is assumed that the projects are mutually exclusive, then under the assumption of 30% discount rate, the choice is between *B* and *D* (and *C* are unprofitable). Both criteria IRR and NPV give the same results - *D* is the best. Under the assumption of 10% discount rate, ranking according to IRR and NPV conflict (except for Project *A*). If the IRR rule is followed, Project *D* should be accepted. But the NPV rule tells that Project is the best. The NPV rule generally gives consistent results in conformity with the wealth maximization principle. Therefore, Project *C* should be accepted following the NPV rule.

51. Payback Period Method:

A = 5 + (500/900) = 5.56 years

B = 5 + (500/1,200) = 5.42 years

C = 2 + (1,000/2,000) = 2.5 years

Net Present Value Method:

$NPV_A = (-5{,}000) + (900 \times 6.145) = (5{,}000) + 5{,}530.5 = ₹530.5$

NPV_B is calculated as follows:

Year	Cash flow (₹)	10% discount factor	Present value (₹)
0	(5000)	1.000	(5,000)
1	700	0.909	636
2	800	0.826	661
3	900	0.751	676
4	1000	0.683	683

Year	Cash flow (₹)	10% discount factor	Present value (₹)
5	1100	0.621	683
6	1200	0.564	677
7	1300	0.513	667
8	1400	0.467	654
9	1500	0.424	636
10	1600	0.386	618
			1591

NPV_C is calculated as follows:

Year	Cash flow (₹)	10% discount factor	Present value (₹)
0	(5000)	1.000	(5,000)
1	2000	0.909	1,818
2	2000	0.826	1,652
3	2000	0.751	1,502
4	1000	0.683	683
			655

Internal Rate of Return

Project *A*

NPV at 12% = (5,000) + 900 × 5.650 = (5,000) + 5085 = 85

NPV at 13% = (5,000) + 900 × 5.426 = (5,000) + 4,883.40 = –116.60

$$= 12 + \left[\frac{85}{85+116.60}\right] \times (13-12) = 12 + 0.42 = 12.42\%.$$

Project B

IRR_B

Year	Cash flow (₹)	10% discount factor	Present value (₹)	16% discount factor	Present value (₹)
0	(5000)	1.000	(5000)	1.000	(5000)
1	700	0.909	636	0.862	603
2	800	0.826	661	0.743	595
3	900	0.751	676	0.641	577
4	1,000	0.683	683	0.552	552
5	1,100	0.621	683	0.476	524
6	1,200	0.564	677	0.410	493
7	1,300	0.513	667	0.354	460
8	1,400	0.467	654	0.305	427
9	1,500	0.424	636	0.263	394
10	1,600	0.386	618	0.227	363
			1,591		(12)

Interpolating: $IRR_B = 10\% + \frac{1,591}{(1,591+12)} \times (16\% - 10\%) = 10\% + 5.94\% = 15.94\%$

Project *C* IRR_C

Year	Cash flow (₹)	15% discount factor	Present value (₹)	18% discount factor	Present value(₹)
0	(5,000)	1.000	(5,000)	1.000	(5,000)
1	2,000	0.870	1,740	0.847	1,694
2	2,000	0.756	1,512	0.718	1,436
3	2,000	0.658	1,316	0.609	1,218
4	1,000	0.572	572	0.516	516
			140		(136)

Interpolating: $|R_C = 15\% + \frac{140}{(140+136)} \times (18\% - 15\%) = 15\% + 1.52\% = 16.52\%$

Accounting Rate of Return:

ARR_A: Average capital employed $= \frac{5,000}{2} =$ ₹ 2,500

Average accounting profit $= \frac{(9,000-5,000)}{10} =$ ₹ 400

$ARR_A = \frac{(400 \times 100)}{2,500} = 16$ per cent

ARR_B: Average accounting profit $= \frac{(11,500-5,000)}{10} =$ ₹ 650

$ARR_B = \frac{(650 \times 100)}{2,500} = 26$ per cent

ARR_C: Average accounting profit $= \frac{(7,000-5,000)}{4} =$ ₹ 500

$ARR_C = \frac{(500 \times 100)}{2,500} = 20$ per cent

(*b*) **Summary of Results**

	A	B	C
Payback (years)	5.5	5.4	2.5
NPV (₹)	530.50	1,591	655
IRR (%)	12.42	15.94	16.52
ARR (%)	16	26	20

₹Comparison of Rankings

Method	Payback	NPV	IRR	ARR
1	C	B	C	B
2	B	C	B	C
3	A	A	A	A

52. Computation of Cash flows **(₹in lakhs)**

	1	2	3	4	5
CFBT (A)	320	320	360	360	300
Less: Depreciation (20%)	160	128	102.4	81.92	65.54
EBT	160	192	257.60	278.08	234.46
Tax (50%) (B)	96	115.20	154.56	166.85	117.23
CFAT (A – B)	256	243.20	256.96	248.77	182.77
Add: CF from sale of assets	-	-	-	-	131.07
Total Cash Flow	256	243.20	256.96	248.77	313.84

***CF from sale of Assets**

Book value = 800 – 160 – 128 – 102.4 – 81.92 – 65.54 = ₹262.14 lakhs

Loss on sale of assets = 0 – 262.14 = ₹262.14 lakhs

Tax saving on loss = 262.14 × 50% = ₹131.07 lakhs

Cash flow from sale of assets = Sale value + tax saving on loss = 0 + 131.07 = ₹131.07 lakhs

Statement of NPV

Particulars	Time	Amount	12%		16%		20%	
			PVF	PV	PVF	PV	PVF	PV
Investment	0	800	1	800	1	800	1	800
		PVCO		**800**		**800**		**800**
Cash flows	1	256	0.89	227.84	0.86	220.16	0.83	212.48
	2	243.20	0.80	194.56	0.74	179.97	0.69	167.81
	3	256.96	0.71	182.44	0.64	164.45	0.58	149.03
	4	248.77	0.64	159.21	0.55	136.82	0.48	119.41
	5	313.84	0.57	178.89	0.48	150.64	0.40	125.54
		PVCI		**941.94**		**852.04**		**774.27**
		NPV		**141.94**		**52.04**		**(25.73)**

Since NPV is positive at 12%, therefore the project should be implemented.

$$IRR = 16\% + \left[\frac{52.04}{52.04-(-25.73)}\right] = 18.64\%$$

53. (*a*) **Computation of NPV at 15% discount rate**

Year	Cash flow (₹)	Discount Factor (15%)	Present value (₹)
0	(7,00,000)	1.000	(7,00,000)
1	(10,00,000)	0.870	(8,70,000)

Year	Cash flow (₹)	Discount Factor (15%)	Present value (₹)
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	2.163	8,65,200
Net Present Value			(1,18,200)

As the net present value is negative, the project is unacceptable.

(*b*) **Computation of NPV if discount rate would be 10% discount rate**

Year	Cash flow (₹)	Discount Factor (10%)	Present value (₹)
0	(7,00,000)	1.000	(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	2.974	11,89,600
Net Present Value			2,51,450

Since NPV is positive, hence the project would be acceptable.

(*c*) **Calculation of IRR:**

$$IRR = LR + \frac{\text{NPV at LR}}{\text{NPV at LR} - \text{NPV at HR}} \times (HR - LR)$$

$$= 10\% + \frac{₹\ 2,51,450}{₹\ 2,51,450 - (-)1,18,200} \times (15\% - 10\%)$$

$$= 10\% + 3.4012 \text{ or } 13.40\%$$

(*d*) **Computation of Pay-back period of the project:**

Payback Period = 6 years:

– ₹7,00,000 – ₹10,00,000 + ₹2,50,000 + ₹3,00,000 + ₹3,50,000 + ₹4,00,000 + ₹4,00,000 = 0

54. (*i*) **Calculation of Pay-back Period**

Cash Outlay of the Project	= ₹80,00,000
Total Cash Inflow for the first five years	= ₹70,00,000
Balance of cash outlay left to be paid back in the 6th year	= ₹10,00,000
Cash inflow for 6th year	= ₹16,00,000

So, the payback period is between 5th and 6th years, i.e.,

$$5 \text{ years} + \frac{₹\ 10,00,000}{₹\ 16,00,000} = 5.625 = 5.625 \text{ years or 5 years 7.5 months}$$

(*ii*) **Calculation of Net Present Value (NPV) @ 10% discount rate:**

Year	Net Cash Inflow (₹)	Present Value at Discount Rate of 10%	Present Value (₹)
	(a)	(b)	(c) = (a) × (b)
1	14,00,000	0.909	12,72,600
2	14,00,000	0.826	11,56,400
3	14,00,000	0.751	10,51,400
4	14,00,000	0.683	9,56,200
5	14,00,000	0.621	8,69,400
6	16,00,000	0.564	9,02,400
7	20,00,000	0.513	10,26,000
8	30,00,000	0.467	14,01,000
9	20,00,000	0.424	8,48,000
10	8,00,000	0.386	3,08,800
			97,92,200

Net Present Value (*NPV*)

= Cash Outflow – Present Value of Cash Inflows = ₹80,00,000 – ₹97,92,200 = 17,92,200

(*iii*) **Calculation of Profitability Index @ 10% discount rate:**

$$\text{Profitability Index} = \frac{\text{Present Value of Cash inflows}}{\text{Cost of the investment}} = \frac{₹\ 97,92,200}{₹\ 80,00,000} = 1.224$$

(*iv*) **Calculation of Internal Rate of Return:**

Net present value @ 10% interest rate factor has already been calculated in (ii) above, we will calculate Net present value @15% rate factor.

Year	Net Cash Inflow (₹)	Present Value at Discount Rate of 15%	Present Value (₹)
	(a)	(b)	(c) = (a) × (b)
1	14,00,000	0.870	12,18,000
2	14,00,000	0.756	10,58,400
3	14,00,000	0.658	9,21,200
4	14,00,000	0.572	8,00,800
5	14,00,000	0.497	6,95,800
6	16,00,000	0.432	6,91,200
7	20,00,000	0.376	7,52,000
8	30,00,000	0.327	9,81,000
9	20,00,000	0.284	5,68,000

Year	Net Cash Inflow (₹)	Present Value at Discount Rate of 15%	Present Value (₹)
10	8,00,000	0.247	1,97,600
			78,84,000

Net Present Value at 15% = ₹78,84,000 – ₹80,00,000 = ₹–1,16,000

As the net present value @ 15% discount rate is negative, hence internal rate of return falls in between 10% and 15%. The correct internal rate of return can be calculated as follows:

$$IRR = L + \frac{NPV_L}{NPV_L - NPV_H}(H - L)$$

$$= 10\% + \frac{₹\ 17,92,200}{₹\ 17,92,200 - (-₹\ 1,16,000)}(15\% - 10\%) = 10\% + \frac{₹\ 17,92,200}{₹\ 19,08,200} \times 5\% = 14.7\%$$

55. Calculation of Cash -outflow at year zero

Particulars	A (₹)	B (₹)
Cost of Machine	5,00,000	5,00,000
Cost of Utilities	1,00,000	2,00,000
Salvage value of Old Machine	(1,00,000)	(1,00,000)
Salvage of value Old Utilities	–	(20,000)
Total Expenditure (Net)	**5,00,000**	**5,80,000**

(*i*)(*a*) **Calculation of NPV**

Year	PV Factor @15%	Machine A		Machine B	
		Cash Inflows (₹)	Discounted value of inflows (₹)	Cash Inflows (₹)	Discounted value of inflows (₹)
0	1.000	(5,00,000)	(5,00,000)	(5,80,000)	(5,80,000)
1	0.870	1,00,000	87,000	2,00,000	1,74,000
2	0.756	1,50,000	1,13,400	2,10,000	1,58,760
3	0.658	1,80,000	1,18,440	1,80,000	1,18,440
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
Salvage	0.497	50,000	24,850	60,000	29,820
Net Present Value			42,580		18,140

Since the Net present Value of both the machines is positive both are acceptable.

(*b*) Discounted Pay-back Period

Year	Machine A		Machine B	
	Discounted cash inflows	Cumulative Discounted cash inflows	Discounted cash inflows	Cumulative Discounted cash inflows
1	87,000	87,000	1,74,000	1,74,000
2	1,13,400	2,00,400	1,58,760	3,32,760
3	1,18,440	3,18,840	1,18,440	4,51,200
4	1,14,400	4,33,240	97,240	5,48,440
5	1,09,340*	5,42,580	49,700*	5,98,140

*Includes salvage value.

Discounted Payback Period (For A and B):

$$\text{Machine A} = 4 \text{ years} + \left(\frac{5,00,000 - 4,33,240}{1,09,340}\right) = 4.61 \text{ years}$$

$$\text{Machine B} = 4 \text{ years} + \left(\frac{5,80,000 - 5,48,440}{49,700}\right) = 4.63 \text{ years}$$

(*c*) Desirability Factor or Profitability Index:

$$\text{Profitability Index (PI)} = \frac{\text{Sum of present value of net cash inflow}}{\text{Initial cash outflow}}$$

$$\text{Machine A} = \frac{₹\ 5,42,580}{₹\ 5,00,000} = 1.08; \text{ Machine} = \frac{₹\ 5,98,140}{₹\ 5,80,000} = 1.03$$

(*ii*) Since the absolute surplus in the case of A is more than B and also the desirability factor, it is better to choose A.

The discounted payback period in both the cases is almost same, also the net present value is positive in both the cases, but the desirability factor (profitability index) is higher in the case of Machine A, it is therefore better to choose Machine A

56. Statement of NPV

Particulars	Time	PVF	Modernization		New Machine	
			Amount	PV	Amount	PV
Cash outflow	0	1	1,40,000	1,40,000	3,50,000	3,50,000
PVCO				**1,40,000**		**3,50,000**
Incremental cash flows	1-5	3.79	35,750	1,35,493	69,250	2,62,458
Salvage value	5	0.621	30,000	18,630	60,000	37,260
PVCI				**1,54,123**		**2,99,718**
NPV				**14,123**		**(50,282)**

NPV in case of Modernization is highest. Thus, it is recommended to modernize the existing machine.

Working Note - 1

Particulars	Existing	Modernization	New Machine
Wages & Salaries	45,000	35,500	15,000
Supervision	20,000	10,000	7,000
Maintenance	25,000	5,000	2,500
Power	30,000	20,000	15,000
Total Cost	1,20,000	70,500	39,500
Savings in cost	–	49,000	80,500
(–) Incremental Dep.	–	$\frac{1,40,000-30,000}{5}$ = 22,000	$\frac{3,50,000-60,000}{5}$ = 58,000
Savings before tax	–	27,500	22,500
(–) Tax @ 50%	–	13,750	11,250
Savings after tax	–	13,750	11,250
(+) Depreciation	–	22,000	58,000
Incremental cash flow	–	35,750	69,250

57. (*i*) Calculation of Net Initial Cash Outflow

Particulars	₹
Cost of New Machine	12,00,000
Less: Sale proceeds of existing machine	2,00,000
Net Purchase Price	10,00,000
Paid in year 0	8,00,000
Paid in year 1	2,00,000

(*ii*) Calculation of Additional Depreciation

Year	1	2	3	4
	₹	₹	₹	₹
Opening WDV of machine	10,00,000	8,00,000	6,40,000	5,12,000
Depreciation on new machine@ 20%	2,00,000	1,60,000	1,28,000	1,02,400
Closing WDV	8,00,000	6,40,000	5,12,000	4,09,600
Depreciation on old machine (4,80,000/8)	60,000	60,000	60,000	60,000
Incremental depreciation	**1,40,000**	**1,00,000**	**68,000**	**42,400**

(*iii*) Calculation of Annual Profit before Depreciation and Tax (PBDT)

Particulars	Incremental Values
Sales	12,25,000
Contribution	6,12,500
Less: Indirect Cost	1,18,750
Profit before Depreciation and Tax (PBDT)	4,93,750

Calculation of Incremental NPV

Year	PVF @ 12%	PBTD (₹)	Incremental Depreciation (₹)	PBT (₹)	Tax @ 30% (₹)	Cash Inflows (₹)	PV of Cash Inflows (₹)
	(1)	(2)	(3)	(4)	(5) = (4)×0.30	(6) = (4) – (5) + (3)	(7) = (6) x (1)
1	0.893	4,93,750	1,40,000	3,53,750	106,125	3,87,625	3,46,149.125
2	0.797	4,93,750	1,00,000	3,93,750	1,18,125	3,75,625	2,99,373.125
3	0.712	4,93,750	68,000	4,25,750	1,27,725	3,66,025	2,60,609.800
4	0.636	4,93,750	42,400	4,51,350	1,35,405	3,58,345	2,27,907.420
			*			*	**11,34,039.470**
Add: PV of Salvage (1,00,000 x 0.636)							63,600
Less: **Initial Cash Outflow** – Year 0 Year 1 (2,00,000 × 0.893)							**8,00,000** **1,78,600**
Less: Working Capital - Year 0 Year 2 (3,00,000 × 0.797)							2,50,000 2,39,100
Add: Working Capital released – Year 4 (5,50,000 × 0.636)							3,49,800
Incremental Net Present Value							**79,739.470**

Since the incremental *NPV* is positive, existing machine should be replaced.

58. Option I: Purchase Machinery and Service Part at the end of Year 1.

Net Present value of cash flow @ 10% per annum discount rate.

$$NPV \text{ (in ₹)} = -1,00,000 + \frac{36,000}{(1.1)} + \frac{36,000}{(1.1)^2} + \frac{36,000}{(1.1)^3} - \frac{20,000}{(1.1)} + \frac{25,000}{(1.1)^3}$$

$$= -1,00,000 + 36,000\,(0.9091 + 0.8264 + 0.7513) - (20,000 \times 0.9091) + (25,000 \times 0.7513)$$

$$= -1,00,000 + (36,000 \times 2.4868) - 18,182 + 18,782.5$$

$NPV = -9,874.7$

Since, Net Present Value is negative; therefore, this option is not to be considered.

If Supplier gives a discount of ₹10,000, then:

NPV (in ₹) = + 10,000 – 9,874.7 = + 125.3

In this case, Net Present Value is positive but very small; therefore, this option may not be advisable.

Option II: Purchase Machinery and Replace Part at the end of Year 2.

$$NPV\ (\text{in } ₹) = -1,00,000 + \frac{36,000}{(1.1)} + \frac{36,000}{(1.1)^2} + \frac{36,000}{(1.1)^3} - \frac{30,800}{(1.1)^2} + \frac{54,000}{(1.1)^4}$$

$$= -1,00,000 + 36,000(0.9091 + 0.8264 + 0.7513) - (30,800 \times 0.8264) + (54,000 \times 0.6830)$$

$$= -1,00,000 + 36,000(2.4868) - 25,453.12 + 36,882$$

$$= -1,00,000 + 89,524.8 - 25,453.12 + 36,882$$

$$NPV = + 953.68$$

Net Present Value is positive, but very low as compared to the investment.

If the Supplier gives a discount of ₹10,000, then:

NPV (in ₹) = 10,000 + 953.68 = 10,953.68

Decision: Option II is worth investing as the net present value is positive and higher as compared to Option I.

59. Statement of NPV

Particulars	Time	PVF	Amount	Present Value
Cost of new machine	0	1	10,00,000	10,00,000
(+) Add. working cap. (2,00,000 – 1,00,000)	0	1	1,00,000	1,00,000
(-) Cash flow from sale of old assets	0	1	(3,00,000)	(3,00,000)
			PVCO	**8,00,000**
Incremental Cash flows (w.n.-1)	1	0.909	2,59,000	2,35,431
	2	0.826	2,50,600	2,06,996
	3	0.751	2,43,880	1,83,154
	4	0.683	2,38,504	1,62,898
Incremental working capital realization	4	0.683	1,00,000	68,300
			PVCI	**8,56,779**
NPV (PVCI – PVCO)				**56,779**

Since the incremental NPV is positive, thus existing machine should be replaced.

Working Note – 1: Calculation of profit before depreciation (PBD)

Particulars	Existing Machine	New Machine
Annual output	300 × 6 × 20 = 36,000	300 × 6 × 40 = 72,000
Sales @ ₹10 per unit	3,60,000	7,20,000
Less: Cost of operation		

Particulars	Existing Machine	New Machine
Material @₹2 per unit	72,000	1,44,000
Labour	1800 × 20 = 36,000	1800 × 30 = 54,000
Fixed OHs	1,00,000	60,000
Profit before Depreciation	1,52,000	4,62,000

Thus, Annual Incremental Profit Before Depreciation = 4,62,000 – 1,52,000 = ₹3,10,000

Working Note – 2: Calculation of basis of depreciation

Particulars	Existing	After Replacement
Purchase price of existing	6,00,000	6,00,000
Less: Depreciation of Yr. 1	1,20,000	1,20,000
Less: Depreciation of Yr. 2	96,000	96,000
WDV of existing machine	3,84,000	3,84,000
Add: Purchase of new	–	10,00,000
Less: Sale of existing	–	3,00,000
Basis for Depreciation	3,84,000	10,84,000

Working Note – 3: Incremental cash flow from sale of assets

Particulars	Year 1	Year 2	Year 3	Year 4
Incremental PBD (A)	3,10,000	3,10,000	3,10,000	3,10,000
New Depreciation	2,16,800	1,73,440	1,38,752	1,11,002
Less: Existing Depreciation	76,800	61,440	49,152	39,322
Incremental Depreciation (B)	1,40,000	1,12,000	89,600	71,680
Incremental PBT (A – B)	1,70,000	1,98,000	2,20,400	2,38,320
Tax @ 30% (C)	51,000	59,400	66,120	71,496
Incremental CFs (A – C)	2,59,000	2,50,600	2,43,880	2,38,504

60. **SK Ltd.**

Equivalent cost of (EAC) of new machine

		(₹)
(i)	Cost of new machine now	90,000
	Add: PV of annual repairs @ ₹10,000 per annum for 8 years (₹10,000 ×4.4873)	44,873
		1,34,873
	Less : PV of salvage value at the end of 8 years (₹20,000 × 0.3269)	6,538
		1,28,335
	Equivalent annual cost (EAC) (1,28,335/4.4873)	28,600

PV of cost of replacing the old machine in each of 4 years with new machine

Scenario	Year	Cash Flow (₹)	PV @ 15%	PV (₹)
Replace Immediately	0	(28,600)	1.00	(28,600)
		40,000	1.00	40,000
				11,400
Replace in one year	1	(28,600)	0.870	(24,882)
	1	(10,000)	0.870	(8,700)
	1	25,0000	0.870	21,750
				(11,832)
Replace in two years	1	(10,000)	0.870	(8,700)
	2	(28,600)	0.756	(21,622)
	2	(20,000)	0.756	(15,120)
	2	15,000	0.756	11,340
				(34,102)
Replace in three years	1	(10,000)	0.870	(8,700)
	2	(20,000)	0.756	(15,120)
	3	(28,600)	0.658	(18,819)
	3	(30,000)	0.658	(19,740)
	3	10,000	0.658	6,580
				(55,799)
Replace in four years	1	(10,000)	0.870	(8,700)
	2	(20,000)	0.756	(15,120)
	3	(30,000)	0.658	(19,740)
	4	(28,600)	0.572	(16,359)
	4	(40,000)	0.572	(22,880)
				(82,799)

Advice: The company should replace the old machine immediately because the PV of cost of replacing the old machine with new machine is least.