

Project Planning and Capital Budgeting

BASIC CONCEPTS AND FORMULAE

1. Feasibility Study

Project feasibility is a test by which an investment is evaluated.

2. Types of Feasibilities

(a) **Market Feasibility:** Demand and price estimates are determined from the market feasibility study. The market feasibility study for a product already selling in the market consists of:

- Study of economic factors and indicators;
- Demand estimation;
- Supply estimation;
- Identification of critical success factors; and
- Estimation of demand-supply gap, which is as follows:

Demand Surplus: Minimum = Min demand – Max supply

Likely = Likely demand – Likely supply

Maximum = Max demand – Likely supply

(b) **Technical Feasibility:** The commercial side of technical details has to be studied along with the technical aspects so that commercial viability of the technology can be evaluated. Project costs along with operating costs are derived from technical feasibility study.

(c) **Financial Feasibility:** Financial feasibility study requires detailed financial analysis based on certain assumptions, workings and calculations like Projections for prices and cost, Period of estimation, Financing alternatives, Financial statements and Computation of ratios such as debt-service coverage ratio (DSCR), net present value (NPV) or internal rate of return (IRR), Projected balance sheet and cash flow statement.

3. Contents of a Project Report

- Details about Promoters;

- Industry Analysis;
- Economic Analysis;
- Cost of Project;
- Inputs regarding raw material, suppliers, etc;
- Technical Analysis;
- Financial Analysis;
- Social Cost Benefit Analysis;
- SWOT Analysis; and
- Project Implementation Schedule.

4. Post Completion Audit

Post-completion audit evaluates actual performance with projected performance. It verifies both revenues and costs.

5. Social Cost Benefit Analysis

Social cost benefits analysis is an approach for evaluation of projects. A technique for appraising isolated projects from the point of view of society as a whole. It assesses gains/losses to society as a whole from the acceptance of a particular project.

Estimation of shadow prices forms the core of social cost benefit methodology. Economic resources have been categorised into goods, services, labour, foreign exchange, shadow price of investment vis-à-vis consumption, shadow price of future consumption vis-à-vis present consumption viz. social rate of discount.

6. Capital Budgeting Under Risk and Uncertainty

Risk denotes variability. Measures of variability used for risk:

- Range (R_g) = $R_h - R_l$

Where,

R_g à range of distribution

R_h à highest value of distribution

R_l à lowest value of distribution

- Mean Absolute Deviation (M.A.D) = $\sum_{i=1}^n p_i | R_i - \bar{R} |$

Where,

p_i à prob. with i th possible value

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R_i à i th possible value of variable

$\bar{R}$ à Arithmetic Mean of distribution / variable

$|R_i - \bar{R}|$ à absolute deviation of i th value from mean.

- Standard Deviation (σ) = $[\sum p_i (R_i - \bar{R})^2]^{1/2}$
- Variance = σ^2
- C.V. = $\sigma / \bar{R}$
- S.V. = $\sum p_i (R_i - \bar{R})^2$
 $(R_i - \bar{R}) = (R_i - \bar{R})$ when $R_i < \bar{R}$
 $= 0$ when $R_i > \bar{R}$

7. Simulation Analysis

In simulation analysis a large number of scenarios are randomly generated and results are calculated to compute the risk.

Following are main steps in simulation analysis:

- Modelling the project. The model shows the relationship of N.P.V. with parameters and exogenous variables;
- Specify values of parameters and probability distributions of exogenous variables;
- Select a value at random from probability distribution of each of the exogenous variables;
- Determine N.P.V. corresponding to the randomly generated value of exogenous variables and pre-specified parameter variables;
- Repeat steps (3) & (4) a large number of times to get a large number of simulated N.P.V.s; and
- Plot frequency distribution of N.P.V.

8. Sensitivity Analysis

Also known as “What if analysis”. It is a useful method to know about the feasibility of a project in variable quantities, due to the uncertainty of the future. The steps in the Sensitivity Analysis are as follows:

- Set up relationship between the basic underlying factors (quantity sold, unit Sales Price, life of project etc.) and N.P.V. (some other criterion of merit);
- Estimate the range of variation and the most likely value of each of the basic underlying factors; and

- Study the effect of N.P.V. of variations in the basic variables (One factor is valued at a time).

9. Methods of Selection of Projects

(a) **Risk Adjusted Discount Rate Method:** it means adjusting discount rate to reflect project risk.

Risk Adjusted Discount Rate for Project 'k' is given by

$$r_k = i + n + d_k$$

Where,

i = risk free rate of interest.

n = adjustment for firm's normal risk.

d_k = adjustment for different risk of project 'k'.

If the project's risk adjusted discount rate (r_k) is specified, the project is accepted if N.P.V. is positive.

$$\text{N.P.V.} = \sum_{t=1}^n A_t / (1 + r_k)^t - I$$

Where,

A_t = Annual Cash Flow

I = Initial Investment

(b) **Certainty Equivalent Method:** Certainty Equivalent Coefficients transform expected values of uncertain flows into their Certainty Equivalents.

$$\text{N.P.V.} = \sum_{t=1}^n \alpha_t A_t / (1+i)^t - I$$

Value of Certainty Equivalent Coefficient (α_t) should lie between 0 and 1.

10. Capital Budgeting Under Capital Rationing

Investment appraisals under capital rationing should be to maximise N.P.V. of the set of investments selected. Due to disparity in the size of the projects, the objective cannot be fulfilled by merely choosing projects on the basis of individual N.P.V. ranking till the budget is exhausted. Combinations approach is adopted in such decisions, which is as follows:

- Find all combinations of projects, which are feasible given the capital budget restriction and project interdependencies; and
- Select the feasible combination having highest N.P.V.

11. Capital Budgeting Under Inflation

Adjustment for inflation is a necessity for capital investment appraisal as inflation will raise the revenues and costs of the project. The net revenues after adjustment

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for inflation shall be equal to net revenues in current terms.

- Annual after tax cash inflow of a project is equal to
 $(R - C - D)(1 - T) + D = (R - C)(1 - T) + DT$

Where,

R = Revenue from project

C = Costs (apart from depreciation) relating to the project

D = Depreciation charges

T = Tax Rate.

- Due to inflation investors require the normal rate of interest to be equal to the actual required rate of return + Rate of inflation.

Where,

$R_N = R_R + P$

R_N = Required rate of return in nominal terms.

R_R = Required rate of return in real terms.

P = Anticipated inflation rate.

- N.P.V. based on consideration of inflation in revenues and costs is given by (effect of inflation on projected cash flows when discount factor contains inflation premium)

$$\text{N.P.V.} = \sum_{t=1}^n \left[\{R_t \cdot {}^t\sum_{r=1}^n (1+i_r) - C_t \cdot {}^t\sum_{r=1}^n (1+i_r)\} (1-T) + D_t T \right] / (1+k)^t - I_0$$

Where,

i_r = Annual inflation rate in revenues for 'r th' year.

C_t = Costs for year 't' with no inflation.

i_r = Annual inflation rate of costs for year 'r'.

T = Tax rate.

D_t = Depreciation charge for year 't'.

I_0 = Initial outlay.

K = Cost of capital (with inflation premium).

12. Decision Trees

By drawing a decision tree, the alternations available to an investment decision are highlighted through a diagram, giving the range of possible outcomes.

The stages set for drawing a decision tree is based on the following rules:

- It begins with a decision point, also known as decision node, represented by a rectangle while the outcome point, also known as chance node, denoted by a circle.
- Decision alternatives are shown by a straight line starting from the decision node.
- The Decision Tree Diagram is drawn from left to right. Rectangles and circles have to be next sequentially numbered.
- Values and Probabilities for each branch are to be incorporated next.
- The expected monetary value (EMV) at the chance node with branches emanating from a circle is the aggregate of the expected values of the various branches that emanate from the chance node.
- The expected value at a decision node with branches emanating from a rectangle is the highest amongst the expected values of the various branches that emanate from the decision node.

13. Capital Asset Pricing Model Approach to Capital Budgeting

It is based on the presumption that total risk of an investment consists of two components (1) Systematic risk (2) Unsystematic risk.

To measure systematic risk and unsystematic risk, the regression relationship used is:

$$R_{jt} = \alpha_j + \beta_j R_{mt} - e_{jt}$$

Where,

R_j = Return on investment j (a project) in period t

R_{mt} = Return on the market portfolio in period t

$\alpha_j E$ = Intercept of the linear regression relationship between R_{jt} and R_{mt}

β_j = Slope of the linear regression relationship between R_{jt} and R_{mt}

As CAPM is based on the assumption that the error term is 0, therefore, the expected value and variance of R_{jt} are:

$$E(R_{jt}) = \alpha_j + \beta_j E(R_{mt}) + 0 = \alpha_j + \beta_j E(R_{mt})$$

$$\text{Var}(R_{jt}) = \beta_j^2 \sigma_m^2 + Q^2 + 0 = \beta_j^2 \sigma_m^2 + Q^2$$

Slope of the regression model is:

$$\beta_j = \rho_{jm} S_j S_m / S_m^2$$

- 14. Estimating the Beta of a Capital Project:** Calculation of Project Beta on the Project's Market Values One-period return of a project is:

$$R_{jt} = (A_{jt} + V_{jt} - V_{j,t-1}) / V_{j,t-1}$$

Project Selection

A project z is acceptable when:

$$[E(R_z) - R_f] / \beta_z > E(R_m) - R_f$$

- 15. Replacement Decision**

A decision concerning whether an existing asset should be replaced by a newer version of the same machine or even a different type of machine that does the same thing as the existing machine.

Steps in Analysis of Replacement Decision

Step I. Net cash outflow (assumed at current time):

- Book value of old system - market value of old system = operating profit/loss from sale
- Operating profit/loss x tax rate = Tax payable/savings from sale
- Cost of new system - (tax payable/savings from sale + market value of old system) = Net cash outflow

Step II. Estimated change in cash flows per year if replacement decision is implemented

Change in cash flow = ((Change in sales + Change in operating costs) - Change in depreciation) (1-tax rate) + Change in depreciation

Step III. Present value of benefits = Present value of yearly cash flows + Present value of estimated salvage of new system

Step IV. Present value of costs = Net cash outflow

Step V. Net present value = Present value of benefits - Present value of costs

Step VI. Decision rule: Accept when present value of benefits > Present value of costs. Reject when the opposite is true.

- 16. Real Option in Capital Budgeting**

An option gives the holder of the option the right, but not the obligation to buy or sell a given amount of underlying asset at a fixed price (strike price or exercise price) at or before the expiration date of the option.

The following is a list of options that may exist in a capital budgeting project:

Long Call:

- Right to invest at some future date, at a certain price
- Generally, any flexibility to invest, to enter a business.

Long Put:

- Right to sell at some future date at a certain price
- Right to abandon at some future date at zero or some certain price
- Generally, any flexibility to disinvest, to exit from a business.

Short Call:

- Promise to sell if the counterparty wants to buy
- Generally, any commitment to disinvest upon the action of another party.

Short Put:

- Promise to buy if the counterparty wants to sell
- Generally, any commitment to invest upon the action of another party.

17. The Binomial Model of Option Pricing

It is based upon a simple formulation for the asset price process, in which the asset, in any time period, can move to one of two possible prices.

$D = \text{Number of units of the underlying asset bought} = (C_u - C_d) / (S_u - S_d)$

Where,

C_u = Value of the call if the stock price is S_u

C_d = Value of the call if the stock price is S_d

Value of the call = Current value of underlying asset * Option Delta - Borrowing needed to replicate the option

18. The Black-Scholes Model

The Black-Scholes model applies when the limiting distribution is the normal distribution, and it explicitly assumes that the price process is continuous and that there are no jumps in asset prices.

Value of call = $SN(d_1) - Ke^{-rt} N(d_2)$

Where,

$$d_1 = [\ln(S/K) + (r + s^2/2)t] / s\sqrt{t}$$

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$$d_2 = d_1 - s \ddot{O}$$

$$\text{Value of Option to Switch} = P_G N\{d_1\} - P_J N\{d_2\}$$

$$d_1 = [\ln (P_G/P_J) + v^2 T/2] / V\sqrt{T}$$

$$d_2 = d_1 - V\sqrt{T}$$

Question 1

What are the issues that need to be considered by an Indian investor and incorporated within the Net Present Value (NPV) model for the evaluation of foreign investment proposals?

Answer

The issues that need to be considered by an Indian investor and incorporated within the Net Present Value (NPV) model for the evaluation of foreign investment proposals are the following:

- (1) *Taxes on income associated with foreign projects:* The host country levies taxes (rates differ from country to country) on the income earned in that country by the Multi National Company (MNC). Major variations that occur regarding taxation of MNC's are as follows:
 - (i) Many countries rely heavily on indirect taxes such as excise duty; value added tax and turnover taxes etc.
 - (ii) Definition of taxable income differs from country to country and also some allowances e.g. rates allowed for depreciation.
 - (iii) Some countries allow tax exemption or reduced taxation on income from certain "desirable" investment projects in the form of tax holidays, exemption from import and export duties and extra depreciation on plant and machinery etc.
 - (iv) Tax treaties entered into with different countries e.g. double taxation avoidance agreements.
 - (v) Offer of tax havens in the form of low or zero corporate tax rates.
- (2) *Political risks:* The extreme risks of doing business in overseas countries can be seizure of property/nationalisation of industry without paying full compensation. There are other ways of interferences in the operations of foreign subsidiary e.g. levy of additional taxes on profits or exchange control regulations may block the flow of funds, restrictions on employment of foreign managerial/technical personnel, restrictions on imports of raw materials/supplies, regulations requiring majority ownership vetting within the host country.

NPV model can be used to evaluate the risk of expropriation by considering probabilities of the occurrence of various events and these estimates may be used to calculate expected cash flows. The resultant expected net present value may be subjected to extensive sensitivity analysis.

- (3) *Economic risks*: The two principal economic risks which influence the success of a project are exchange rate changes and inflation.

The impact of exchange rate changes and inflation upon incremental revenue and upon each element of incremental cost needs to be computed.

Question 2

Many companies calculate the internal rate of return of the incremental after-tax cash-flows from financial leases.

What problems do you think this may give rise to? To what rate should the internal rate of return be compared? Discuss.

Answer

Main problems faced in using Internal Rate of Return can be enumerated as under:

- (1) The IRR method cannot be used to choose between alternative lease bases with different lives or payment patterns.
- (2) If the firms do not pay tax or pay at constant rate, then IRR should be calculated from the lease cash-flows and compared to after-tax rate of interest. However, if the firm is in a temporary non-tax paying status, its cost of capital changes over time, and there is no simple standard of comparison.
- (3) Another problem is that risk is not constant. For the lessee, the payments are fairly riskless and interest rate should reflect this. The salvage value for the asset, however, is probably much riskier. As such two discount rates are needed. IRR gives only one rate, and thus, each cash-flow is not implicitly discounted to reflect its risk.
- (4) Multiple roots rarely occur in capital budgeting since the expected cashflow usually changes signs once. With leasing, this is not the case often. A lessee will have an immediate cash inflow, a series of outflows for a number of years, and then an inflow during the terminal year. With two changes of sign, there may be, in practice frequently two solutions for the IRR.

Question 3

Distinguish between Net Present-value and Internal Rate of Return.

Answer

NPV and IRR: NPV and IRR methods differ in the sense that the results regarding the choice of an asset under certain circumstances are mutually contradictory under two methods. IN case of mutually exclusive investment projects, in certain situations, they may give contradictory results such that if the NPV method finds one proposal acceptable, IRR favours another. The different rankings given by the NPV and IRR methods could be due to size disparity problem, time disparity problem and unequal expected lives.

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The net present value is expressed in financial values whereas internal rate of return (IRR) is expressed in percentage terms.

In net present value cash flows are assumed to be re-invested at cost of capital rate. In IRR re-investment is assumed to be made at IRR rates.

Question 4

Write short note on Certainty Equivalent Approach.

Answer

Certainty Equivalent Approach (CE): This approach recognizes risk in capital budgeting analysis by adjusting estimated cash flows and employs risk free rate to discount the adjusted cash-flows. Under this method, the expected cash flows of the project are converted to equivalent riskless amounts. The greater the risk of an expected cash flow, the smaller the certainty equivalent values for receipts and longer the CE value for payment. This approach is superior to the risk adjusted discounted approach as it can measure risk more accurately.

This is yet another approach for dealing with risk in capital budgeting to reduce the forecasts of cash flows to some conservative levels. In certainty Equivalent approach we incorporate risk to adjust the cash flows of a proposal so as to reflect the risk element. The certainty Equivalent approach adjusts future cash flows rather than discount rates. This approach explicitly recognizes risk, but the procedure for reducing the forecasts of cash flows is implicit and likely to be inconsistent from one investment to another.

Question 5

What is the sensitivity analysis in Capital Budgeting?

Answer

Sensitivity Analysis in Capital Budgeting: Sensitivity analysis is used in Capital budgeting for more precisely measuring the risk. It helps in assessing information as to how sensitive are the estimated parameters of the project such as cash flows, discount rate, and the project life to the estimation errors. Future being always uncertain and estimations are always subject to error, sensitivity analysis takes care of estimation errors by using a number of possible outcomes in evaluating a project. The methodology adopted in sensitivity analysis is to evaluate a project by using a number of estimated cash flows so as to provide to the decision maker an insight into the variability of outcome. Thus, it is a technique of risk analysis which studies the responsiveness of a criterion of merit like NPV or IRR to variation in underlying factors like selling price, quantity sold, returns from an investment etc.

Sensitivity analysis answers questions like,

- (i) What happens to the present value (or some other criterion of merit) if flows are, say ₹ 50,000 than the expected ₹ 80,000?
- (ii) What will happen to NPV if the economic life of the project is only 3 years rather than

expected 5 years?

Therefore, wherever there is an uncertainty, of whatever type, the sensitivity analysis plays a crucial role. However, it should not be viewed as the method to remove the risk or uncertainty, it is only a tool to analyse and measure the risk and uncertainty. In terms of capital budgeting the possible cash flows are based on three assumptions:

- (a) Cash flows may be worst (pessimistic)
- (b) Cash flows may be most likely.
- (c) Cash flows may be most optimistic.

Sensitivity analysis involves three steps

- (1) Identification of all those variables having an influence on the project's NPV or IRR.
- (2) Definition of the underlying quantitative relationship among the variables.
- (3) Analysis of the impact of the changes in each of the variables on the NPV of the project.

The decision maker, in sensitivity analysis always asks himself the question – what if?

Question 6

Write short note on Social Cost Benefit analysis.

Answer

Social Cost Benefit Analysis: It is increasingly realised that commercial evaluation of projects is not enough to justify commitment of funds to a project especially when the project belongs to public utility and irrespective of its financial viability it needs to be implemented in the interest of the society as a whole. Huge amount of funds are committed every year to various public projects of all types—industrial, commercial and those providing basic infrastructure facilities. Analysis of such projects has to be done with reference to the social costs and benefits since they cannot be expected to yield an adequate commercial rate of return on the funds employed at least during the short period. A social rate of return is more important. The actual costs or revenues do not necessarily reflect the monetary measurement of costs or benefits to the society. This is because the market price of goods and services are often grossly distorted due to various artificial restrictions and controls from authorities, hence a different yardstick has to be adopted for evaluating a particular project of social importance and its costs and benefits are valued at 'opportunity cost' or shadow prices to judge the real impact of their burden as costs to the society. Thus, social cost benefit analysis conducts a monetary assessment of the total cost and revenues or benefits of a project, paying particular attention to the social costs and benefits which do not normally feature in conventional costing.

United Nations Industrial Development Organisation (UNIDO) and Organisation of Economic Cooperation and Development (OECD) have done much work on Social Cost Benefit analysis. A great deal of importance is attached to the social desirability of projects like employment

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generation potential, value addition, foreign exchange benefit, living standard improvement etc. UNIDO and OECD approaches need a serious consideration in the calculation of benefits and costs to the society. This technique has got more relevance in the developing countries where public capital needs precedence over private capital.

Question 7

Comment briefly on the social cost benefit analysis in relation to evaluation of an Industrial project.

Answer

Social Cost-Benefit Analysis of Industrial Projects

This refers to the moral responsibility of both PSU and private sector enterprises to undertake socially desirable projects – that is, the social contribution aspect needs to be kept in view.

Industrial capital investment projects are normally subjected to rigorous feasibility analysis and cost benefit study from the point of view of the investors. Such projects, especially large ones often have a ripple effect on other sections of society, local environment, use of scarce national resources etc. Conventional cost-benefit analysis ignores or does not take into account or ignores the societal effect of such projects. Social Cost Benefit (SCB) is recommended and resorted to in such cases to bring under the scanner the social costs and benefits.

SCB sometimes changes the very outlook of a project as it brings elements of study which are unconventional yet very relevant. In a study of a famous transportation project in the UK from a normal commercial angle, the project was to run an annual deficit of more than 2 million pounds. The evaluation was adjusted for a realistic fare structure which the users placed on the services provided which changed the picture completely and the project got justified. Large public sector/service projects especially in under-developed countries which would get rejected on simple commercial considerations will find justification if the social costs and benefits are considered.

SCB is also important for private corporations who have a moral responsibility to undertake socially desirable projects, use scarce natural resources in the best interests of society, generate employment and revenues to the national exchequer.

Indicators of the social contribution include

- (a) Employment potential criterion;
- (b) Capital output ratio – that is the output per unit of capital;
- (c) Value added per unit of capital;
- (d) Foreign exchange benefit ratio.

Question 8

Write a brief note on project appraisal under inflationary conditions.

Answer**Project Appraisal under Inflationary Conditions**

Project Appraisal normally involves feasibility evaluation from technical, commercial, economic and financial aspects. It is generally an exercise in measurement and analysis of cash flows expected to occur over the life of the project. The project cash outflows usually occur initially and inflows come in the future.

During inflationary conditions, the project cost increases on all heads viz. labour, raw material, fixed assets such as equipments, plant and machinery, building material, remuneration of technicians and managerial personnel etc. Beside this, inflationary conditions erode purchasing power of consumers and affect the demand pattern. Thus, not only cost of production but also the projected statement of profitability and cash flows are affected by the change in demand pattern. Even financial institutions and banks may revise their lending rates resulting in escalation in financing cost during inflationary conditions. Under such circumstances, project appraisal has to be done generally keeping in view the following guidelines which are usually followed by government agencies, banks and financial institutions.

- (i) It is always advisable to make provisions for cost escalation on all heads of cost, keeping in view the rate of inflation during likely period of delay in project implementation.
- (ii) The various sources of finance should be carefully scrutinised with reference to probable revision in the rate of interest by the lenders and the revision which could be effected in the interest bearing securities to be issued. All these factors will push up the cost of funds for the organization.
- (iii) Adjustments should be made in profitability and cash flow projections to take care of the inflationary pressures affecting future projections.
- (iv) It is also advisable to examine the financial viability of the project at the revised rates and assess the same with reference to economic justification of the project. The appropriate measure for this aspect is the economic rate of return for the project which will equate the present value of capital expenditures to net cash flows over the life of the projects. The rate of return should be acceptable which also accommodates the rate of inflation per annum.
- (v) In an inflationary situation, projects having early payback periods should be preferred because projects with long payback period are more risky.

Under conditions of inflation, the project cost estimates that are relevant for a future date will suffer escalation. Inflationary conditions will tend to initiate the measurement of future cash flows. Either of the following two approaches may be used while appraising projects under such conditions:

- (i) Adjust each year's cash flows to an inflation index, recognising selling price increases and cost increases annually; or

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- (ii) Adjust the 'Acceptance Rate' (cut-off) suitably retaining cash flow projections at current price levels.

An example of approach (ii) above can be as follows:

Normal Acceptance Rate	:	15.0%
Expected Annual Inflation	:	5.0%
Adjusted Discount Rate	:	15.0×1.05 or 15.75%

It must be noted that measurement of inflation has no standard approach nor is easy. This makes the job of appraisal a difficult one under such conditions.

Question 9

What is Capital rationing?

Answer

Capital Rationing: When there is a scarcity of funds, capital rationing is resorted to. Capital rationing means the utilization of existing funds in most profitable manner by selecting the acceptable projects in the descending order or ranking with limited available funds. The firm must be able to maximize the profits by combining the most profitable proposals. Capital rationing may arise due to (i) external factors such as high borrowing rate or non-availability of loan funds due to constraints of Debt-Equity Ratio; and (ii) Internal Constraints Imposed by management. Project should be accepted as a whole or rejected. It cannot be accepted and executed in piecemeal.

IRR or NPV are the best basis of evaluation even under Capital Rationing situations. The objective is to select those projects which have maximum and positive NPV. Preference should be given to interdependent projects. Projects are to be ranked in the order of NPV. Where there is multi-period Capital Rationing, Linear Programming Technique should be used to maximize NPV. In times of Capital Rationing, the investment policy of the company may not be the optimal one.

In nutshell Capital Rationing leads to:

- (i) Allocation of limited resources among ranked acceptable investments.
- (ii) This function enables management to select the most profitable investment first.
- (iii) It helps a company use limited resources to the best advantage by investing only in the projects that offer the highest return.
- (iv) Either the internal rate of return method or the net present value method may be used in ranking investments.

Question 10

Explain the concept 'Zero date of a Project' in project management.

Answer

Zero Date of a Project means a date is fixed from which implementation of the project begins. It is a starting point of incurring cost. The project completion period is counted from the zero date. Pre-project activities should be completed before zero date. The pre-project activities should be completed before zero date. The pre-project activities are:

- a. Identification of project/product
- b. Determination of plant capacity
- c. Selection of technical help/collaboration
- d. Selection of site.
- e. Selection of survey of soil/plot etc.
- f. Manpower planning and recruiting key personnel
- g. Cost and finance scheduling.

Question 11

What are the steps for simulation analysis?

Answer

Steps for simulation analysis.

1. Modelling the project- The model shows the relationship of N.P.V. with parameters and exogenous variables. (Parameters are input variables specified by decision maker and held constant over all simulation runs. Exogenous variables are input variables, which are stochastic in nature and outside the control of the decision maker).
2. Specify values of parameters and probability distributions of exogenous variables.
3. Select a value at random from probability distribution of each of the exogenous variables.
4. Determine N.P.V. corresponding to the randomly generated value of exogenous variables and pre-specified parameter variables.
5. Repeat steps (3) & (4) a large number of times to get a large number of simulated N.P.V.s.
6. Plot frequency distribution of N.P.V.

Question 12

XYZ Ltd., an infrastructure company is evaluating a proposal to build, operate and transfer a section of 35 kms. of road at a project cost of ₹200 crores to be financed as follows:

Equity Shares Capital ₹ 50 crores, loans at the rate of interest of 15% p.a. from financial institutions ₹150 crores. The Project after completion will be opened to traffic and a toll will be collected for a period of 15 years from the vehicles using the road. The company is also

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required to maintain the road during the above 15 years and after the completion of that period, it will be handed over to the Highway authorities at zero value. It is estimated that the toll revenue will be ₹ 50 crores per annum and the annual toll collection expenses including maintenance of the roads will amount to 5% of the project cost. The company considers to write off the total cost of the project in 15 years on a straight line basis. For Corporate Income-tax purposes the company is allowed to take depreciation @ 10% on WDV basis. The financial institutions are agreeable for the repayment of the loan in 15 equal annual instalments – consisting of principal and interest.

Calculate Project IRR and Equity IRR. Ignore Corporate taxation.

Explain the difference in Project IRR and Equity IRR

Answer

Computation of Project IRR

Project IRR is computed by using the following equation:

Where,

CO_0 = Cash outflow at time zero

CF_t = Net cash inflow at different points of time

N = Life of the project and

R = Rate of discount (IRR)

Now,

CO_0 = ₹ 200 crores

CF_t = ₹ 40 crores p.a. for 15 years

(Refer to working note (i))

Therefore,

$$₹ 200 \text{ crore} = \frac{₹ 40 \text{ crores}}{(1 + r)^{15}}$$

The value of IRR of the project:

1. An approximation of IRR is made on the basis of cash flow data. A rough approximation may be made with reference to the payback period. The payback period in the given case is 5 years i.e. $\frac{₹ 200 \text{ crores}}{₹ 40 \text{ crores}}$. From the PVAF table the closest figures are given in rate 18% (5.092) and the rate 19% (4.876). This means the IRR of the project is expected to be between 18% and 19%.
2. The estimate of IRR cash inflow of the project for both these rates is as follows:

At 18% = ₹ 40 crores × PVAF (18%, 15 years)

= ₹ 40 crores × 5.092

= ₹ 203.68 crores

At 19% = ₹ 40 crores × PVAF (19%, 15 years)

= ₹ 40 crores × 4.876

= ₹ 195.04 crores

3. The exact IRR by interpolating between 18% and 19% is worked out as follows:

$$\begin{aligned} \text{IRR} &= 18\% + \frac{\text{₹ 203.68 crores} - \text{₹ 200 crores}}{\text{₹ 203.68 crores} - \text{₹ 195.04 crores}} \times 1\% \\ &= 18\% + \frac{\text{₹ 3.68 crores}}{\text{₹ 8.64 crores}} \times 1\% \\ &= 18\% + 0.426\% \\ &= 18.43\% \end{aligned}$$

Therefore, the IRR of the project is 18.43%.

Working Notes:

- (i) Net cash inflow of the project

Cash inflow	₹
Toll revenue	50 crores p.a. for 15 years
Cash outflow	₹
Toll collection expenses including maintenance of the roads	10 crores p.a. for 15 years
(5% of ₹ 200 crores)	
Net cash inflow	<u>40 crores p.a. for 15 years</u>

Note: Since corporate taxes is not payable. The impact of depreciation need not be considered.

Computation of Equity IRR

Equity IRR is computed by using the following equation:

$$\text{Cash inflow at zero date from equity shareholders} = \frac{\text{Cash inflow available for equity shareholders}}{(1+r)^n}$$

Where,

r = Equity IRR

Here, Cash inflow at zero date from equity shareholders = ₹ 50 crores

(Refer to working note)

$$₹ 50 \text{ crores} = \frac{₹ 14.35 \text{ crores}}{(1 + r)^{15}}$$

1. An approximation of IRR is made on the basis of cash flow data. A rough approximation may be made with reference to the payable period. The payable period in the given case is $3.484 \frac{\text{₹ 50 crores}}{\text{₹ 14.35 crores}}$. From the PVAF table the closest figure may be about 25% and 30%. This means the equity IRR of project must be between 25% and 30%.

3. IRR by using Interpolation Formula will be

$$= 25\% + 3.17\% = 28.17\%$$

- Hence, equated yearly instalment will be ₹ 150 crores/5.847 i.e. ₹ 25.65 crores.

- | | |
|--------------------------------|----------------|
| Net cash inflow of the project | ₹ 40.00 crores |
|--------------------------------|----------------|

[Refer to working note (i)]

Equated yearly instalment of the project ₹ 25.65 crores

[Refer to working note (ii)]

Cash inflow available for equity shareholders ₹ 14.35 crores

Difference in Project IRR and Equity IRR:

The project IRR is 18.4% whereas Equity IRR is 28%. This is attributed to the fact that XYZ Ltd. is earning 18.4% on the loan from financial institution but paying only 15%. The difference between the return and cost of funds from financial institution has enhanced equity IRR. The 3.4% (18.4% - 15%) earnings on ₹ 150 crores goes to equity shareholders who have invested ₹ 50 crore i.e.

$$3.4\% \times \frac{₹ 150 \text{ crores}}{₹ 50 \text{ crores}} = 10.2\% \text{ is added to the project IRR which gives equity IRR of } 28\%.$$

Question 13

X Ltd. an existing profit-making company, is planning to introduce a new product with a projected life of 8 years. Initial equipment cost will be ₹ 120 lakhs and additional equipment costing ₹ 10 lakhs will be needed at the beginning of third year. At the end of the 8 years, the original equipment will have resale value equivalent to the cost of removal, but the additional equipment would be sold for ₹ 1 lakhs. Working Capital of ₹ 15 lakhs will be needed. The 100% capacity of the plant is of 4,00,000 units per annum, but the production and sales-volume expected are as under:

Year	Capacity in percentage
1	20
2	30
3-5	75
6-8	50

A sale price of ₹ 100 per unit with a profit-volume ratio of 60% is likely to be obtained. Fixed Operating Cash Cost are likely to be ₹ 16 lakhs per annum. In addition to this the advertisement expenditure will have to be incurred as under:

Year	1	2	3-5	6-8
Expenditure in ₹ lakhs each year	30	15	10	4

The company is subject to 50% tax, straight-line method of depreciation, (permissible for tax purposes also) and taking 12% as appropriate after tax Cost of Capital, should the project

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be accepted?

Answer

(a) Computation of initial cash outlay

(₹ in lakhs)

Equipment Cost (0)	120
Working Capital (0)	<u>15</u>
	<u>135</u>

Calculation of Cash Inflows:

Year	1	2	3-5	6-8
Sales in units	80,000	1,20,000	3,00,000	2,00,000
	₹	₹	₹	₹
Contribution @ ₹ 60 p.u.	48,00,000	72,00,000	1,80,00,000	1,20,00,000
Fixed cost	16,00,000	16,00,000	16,00,000	16,00,000
Advertisement	30,00,000	15,00,000	10,00,000	4,00,000
Depreciation	<u>15,00,000</u>	<u>15,00,000</u>	<u>16,50,000</u>	<u>16,50,000</u>
Profit/(loss)	(13,00,000)	26,00,000	1,37,50,000	83,50,000
Tax @ 50%	<u>Nil</u>	<u>13,00,000</u>	<u>68,75,000</u>	<u>41,75,000</u>
Profit/(loss) after tax	(13,00,000)	13,00,000	68,75,000	41,75,000
Add: Depreciation	<u>15,00,000</u>	<u>15,00,000</u>	<u>16,50,000</u>	<u>16,50,000</u>
Cash Inflow	<u>2,00,000</u>	<u>28,00,000</u>	<u>85,25,000</u>	<u>58,25,000</u>

Computation of PV of CIF

Year	CIF	PV Factor @ 12%	
	₹		₹
1	2,00,000	0.893	1,78,600
2	28,00,000	0.797	22,31,600
3	85,25,000	0.712	60,69,800
4	85,25,000	0.636	54,21,900
5	85,25,000	0.567	48,33,675

6	58,25,000	0.507	29,53,275
7	58,25,000	0.452	26,32,900
8	58,25,000	0.404	23,53,300
WC	15,00,000	0.404	6,06,000
SV	1,00,000	0.404	<u>40,400</u>
			2,73,21,450
	PV of COF		1,35,00,000
	Additional Investment = ₹ 10,00,000 × 0.797		<u>7,97,000</u>
			<u>1,42,97,000</u>
	NPV		<u>1,30,24,450</u>

Recommendation: Accept the project in view of positive NPV.

Question 14

ABC Co. is considering a new sales strategy that will be valid for the next 4 years. They want to know the value of the new strategy. Following information relating to the year which has just ended, is available:

Income Statement	₹
Sales	20,000
Gross margin (20%)	4,000
Administration, Selling & distribution expense (10%)	2,000
PBT	2,000
Tax (30%)	600
PAT	1,400
Balance Sheet Information	
Fixed Assets	8,000
Current Assets	4,000
Equity	12,000

If it adopts the new strategy, sales will grow at the rate of 20% per year for three years. The gross margin ratio, Assets turnover ratio, the Capital structure and the income tax rate will remain unchanged.

Depreciation would be at 10% of net fixed assets at the beginning of the year.

The Company's target rate of return is 15%.

Determine the incremental value due to adoption of the strategy.

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Answer

<i>Projected Balance Sheet</i>				
	Year 1	Year 2	Year 3	Year 4
Fixed Assets (40%) of Sales	9,600	11,520	13,824	13,824
Current Assets (20%) of Sales	4,800	5,760	6,912	6,912
Total Assets	14,400	17,280	20,736	20,736
Equity	14,400	17,280	20,736	20,736

Projected Cash Flows:-

	Year 1	Year 2	Year 3	Year 4
Sales	24,000	28,800	34,560	34,560
PBT (10%) of sale	2,400	2,880	3,456	3,456
PAT (70%)	1,680	2,016	2,419.20	2,419.20
Depreciation	800	960	1,152	1,382
Addition to Fixed Assets	2,400	2,880	3,456	1,382
Increase in Current Assets	800	960	1,152	-
Operating cash flow	(720)	(864)	(1,036.80)	2,419.20

Projected Cash Flows:-

Present value of Projected Cash Flows:-

<i>Cash Flows</i>	<i>PV at 15%</i>	<i>PV</i>
-720	0.870	-626.40
-864	0.756	-653.18
-1,036.80	0.658	<u>-682.21</u>
		-1,961.79

Residual Value - $2419.20/0.15 = 16,128$

Present value of Residual value = $16128/(1.15)^3$
 = $16128/1.521 = 10603.55$

Total shareholders' value = $10,603.55 - 1,961.79 = 8,641.76$

Pre strategy value = $1,400 / 0.15 = 9,333.33$

\ Value of strategy = $8,641.76 - 9,333.33 = 691.57$

Conclusion: The strategy is not financially viable

Question 15

DL Services is in the business of providing home Services like plumbing, sewerage line cleaning etc. There is a proposal before the company to purchase a mechanized sewerage cleaning line for a sum of ₹20 lacs. The life of the machine is 10 years. The present system of the company is to use manual labour for the job. You are provided the following information:

<i>Cost of machine</i>	<i>20 lakhs</i>
<i>Depreciation</i>	<i>20% p.a. straight line</i>
<i>Operating cost</i>	<i>₹5 lacs per annum</i>
<i>Present system</i>	
<i>Manual labour</i>	<i>200 persons</i>
<i>Cost of Manual labour</i>	<i>₹10,000 (ten thousand) per person per annum</i>

The company has an after tax cost of funds of 10% per annum. The applicable rate of tax inclusive of surcharge and cess is 35%.

Based on the above you are required to:

- (i) State whether it is advisable to purchase the machine.*
- (ii) Compute the savings/additional cost as applicable, if the machine is purchased.*

Answer

Present System

Cost per annum	
200 persons @ ₹10,000 per annum	20,00,000
Cumulative Annuity factor at 10%	6.1446
Present value of cash outflow over a period of ten years at 10%	122,89,200
Tax benefit at 35% for 10 years	43,01,220
Net cost over ten years	79,87,980
If machine is purchased	
Cost of Machine	20,00,000
Depreciation per annum	4,00,000
Annual cost of operation	5,00,000
Present value of operating cost for 10 years at 10%	30,72,300

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Tax saving on operating cost at 35% for 10 years	10,75,305
Net operating cost	19,96,995
Annuity factor for 5 years at 10%	3.7908
Tax saving on depreciation at 35%	5,30,712
Summary	
Outflow on machine	20,00,000
Less: Tax saving on depreciation of Machine	-5,30,712
Add: Operating cost over 10 years	19,96,995
Total cost of machine over 10 years	34,66,283
Total saving	45,21,697
Since there is a saving of ₹45.21 lacs it is advisable to purchase the machine.	

Alternative Solution:

Calculation of Savings in operating cost if the mechanized cleaning line is purchased:

Annual Cost of the present system – cost of manual labour	₹ lakhs
200 persons × ₹10,000	20.00
Less: Operating cost with the new line	5.00
Annual Savings	15.00

Calculation of incremental cash inflows if the mechanized cleaning line is purchased:

Year 1 - 5		
		₹ lakhs
Annual Savings in operating cost (before tax)		15.00
Less: Annual depreciation @ 20% on cost		<u>4.00</u>
Taxable annual incremental income		11.00
Less: Tax @ 35%		<u>3.85</u>
After-tax annual incremental income		7.15
Add: Annual depreciation		4.00
Annual incremental cash-in-flow		11.15
Present Value Factor (of an Annuity for a period of 5 years @ 10%)		3.79

Present Value of 5-year annual incremental cash-in-flow (₹ Lakhs)		42.26
Year 6 – 10		
Annual Savings in operating cost (before tax)		15.00
Less: Tax @ 35%		5.25
After-tax annual incremental income/cash in flow		9.75
Present Value Factor (of an Annuity between year 6 and 10)		2.35
Present Value of cash-in-flow in years 6 to 10 (₹ Lakhs)		22.91
(Salvage value presumed 'nil')		
		₹ in lakhs
<i>Calculation of Net Present Value:</i>		
Aggregate Present Value of Cash inflows in years 1 – 10 (42.26 + 22.91)		65.17
Less: Initial investment – cost of machine		20.00
Net Present Value	(+)	45.17

Advise: Since the NPV is positive, it is advisable to purchase the mechanized line.

Question 16

Skylark Airways is planning to acquire a light commercial aircraft for flying class clients at an investment of ₹ 50,00,000. The expected cash flow after tax for the next three years is as follows:

Year 1		Year 2		Year 3	
CFAT	Probability	CFAT	Probability	CFAT	Probability
14,00,000	0.1	15,00,000	0.1	18,00,000	0.2
18,00,000	0.2	20,00,000	0.3	25,00,000	0.5
25,00,000	0.4	32,00,000	0.4	35,00,000	0.2
40,00,000	0.3	45,00,000	0.2	48,00,000	0.1

The Company wishes to take into consideration all possible risk factors relating to airline operations. The company wants to know:

- The expected NPV of this venture assuming independent probability distribution with 6 per cent risk free rate of interest.
- The possible deviation in the expected value.
- How would standard deviation of the present value distribution help in Capital

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Budgeting decisions?

Answer

(i) **Expected NPV**

(₹ in lakhs)

Year I			Year II			Year III		
CFAT	P	CF×P	CFAT	P	CF×P	CFAT	P	CF×P
14	0.1	1.4	15	0.1	1.5	18	0.2	3.6
18	0.2	3.6	20	0.3	6.0	25	0.5	12.5
25	0.4	10.0	32	0.4	12.8	35	0.2	7.0
40	0.3	<u>12.0</u>	45	0.2	<u>9</u>	48	0.1	<u>4.8</u>
	$\bar{x}$ or $\overline{CF}$	<u>27.0</u>		$\bar{x}$ or $\overline{CF}$	<u>29.3</u>			$\bar{x}$ or $\overline{CF}$ <u>27.9</u>

NPV	PV factor @ 6%	Total PV
27	0.943	25.461
29.3	0.890	26.077
27.9	0.840	<u>23.436</u>
	PV of cash inflow	74.974
	Less: Cash outflow	<u>50.000</u>
	NPV	<u>24.974</u>

(ii) **Possible deviation in the expected value**

Year I				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_1	$(X - \bar{X})^2 P_1$
14 – 27	-13	169	0.1	16.9
18 – 27	-9	81	0.2	16.2
25 – 27	-2	4	0.4	1.6
40 – 27	13	169	0.3	<u>50.7</u>
				<u>85.4</u>

$$s_1 = \sqrt{85.4} = 9.241$$

Year II				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_2	$(X - \bar{X})^2 \times P_2$
15-29.3	-14.3	204.49	0.1	20.449
20-29.3	-9.3	86.49	0.3	25.947
32-29.3	2.7	7.29	0.4	2.916
45-29.3	15.7	246.49	0.2	<u>49.298</u>
				<u>98.61</u>

$$s_2 = \sqrt{98.61} = 9.930$$

Year III				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_3	$(X - \bar{X})^2 \times P_3$
18-27.9	-9.9	98.01	0.2	19.602
25-27.9	-2.9	8.41	0.5	4.205
35-27.9	7.1	50.41	0.2	10.082
48-27.9	20.1	404.01	0.1	<u>40.401</u>
				<u>74.29</u>

$$s_3 = \sqrt{74.29} = 8.619$$

Standard deviation about the expected value:

$$= \sqrt{\frac{85.4}{(1.06)^2} + \frac{98.61}{(1.06)^4} + \frac{74.29}{(1.06)^6}} = 14.3696$$

- (iii) Standard deviation is a statistical measure of dispersion; it measures the deviation from a central number i.e. the mean.

In the context of capital budgeting decisions especially where we take up two or more projects giving somewhat similar mean cash flows, by calculating standard deviation in such cases, we can measure in each case the extent of variation. It can then be used to identify which of the projects is least riskier in terms of variability of cash flows.

A project, which has a lower coefficient of variation will be preferred if sizes are heterogeneous.

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Besides this, if we assume that probability distribution is approximately normal we are able to calculate the probability of a capital budgeting project generating a net present value less than or more than a specified amount.

Question 17

- (a) Cyber Company is considering two mutually exclusive projects. Investment outlay of both the projects is ₹ 5,00,000 and each is expected to have a life of 5 years. Under three possible situations their annual cash flows and probabilities are as under:

Situation	Probabilities	Cash Flow	
		Project A	Project B
Good	0.3	6,00,000	5,00,000
Normal	0.4	4,00,000	4,00,000
Worse	0.3	2,00,000	3,00,000

The cost of capital is 7 per cent, which project should be accepted? Explain with workings.

- (b) A company is considering Projects X and Y with following information:

Project	Expected NPV (₹)	Standard deviation
X	1,22,000	90,000
Y	2,25,000	1,20,000

- (i) Which project will you recommend based on the above data?
(ii) Explain whether your opinion will change, if you use coefficient of variation as a measure of risk.
(iii) Which measure is more appropriate in this situation and why?

Answer

(a) Project A

Expected Net Cash flow (ENCF)

$$0.3 (6,00,000) + 0.4 (4,00,000) + 0.3 (2,00,000) = 4,00,000$$

$$\sigma^2 = 0.3 (6,00,000 - 4,00,000)^2 + 0.4 (4,00,000 - 4,00,000)^2 + 0.3 (2,00,000 - 4,00,000)^2$$

$$\sigma = \sqrt{24,00,00,00,000}$$

$$\sigma = 1,54,919.33$$

$$\text{Present Value of Expected Cash Inflows} = 4,00,000 \times 4.100 = 16,40,000$$

$$NPV = 16,40,000 - 5,00,000 = 11,40,000$$

Project B

$$ENCF = 0.3 (5,00,000) + 0.4 (4,00,000) + 0.3 (3,00,000) = 4,00,000$$

$$\sigma^2 = 0.3 (5,00,000 - 4,00,000)^2 + 0.4 (4,00,000 - 4,00,000)^2 + 0.3 (3,00,000 - 4,00,000)^2$$

$$\sigma = \sqrt{6,00,00,00,000}$$

$$\sigma = 77,459.66$$

$$\text{Present Value of Expected Cash Inflows} = 4,00,000 \times 4.100 = 16,40,000$$

$$NPV = 16,40,000 - 5,00,000 = 11,40,000$$

Recommendation: NPV in both projects being the same, the project should be decided on the basis of standard deviation and hence project 'B' should be accepted having lower standard deviation, means less risky.

- (b) (i) On the basis of standard deviation project X be chosen because it is less risky than Project Y having higher standard deviation.

$$(ii) CV_x = \frac{SD}{ENPV} = \frac{90,000}{1,22,000} = 0.738$$

$$CV_y = \frac{1,20,000}{2,25,000} = 0.533$$

On the basis of Co-efficient of Variation (C.V.) Project X appears to be more risky and Y should be accepted.

- (iii) However, the NPV method in such conflicting situation is best because the NPV method is in compatibility of the objective of wealth maximisation in terms of time value.

Question 18

Project X and Project Y are under the evaluation of XY Co. The estimated cash flows and their probabilities are as below:

Project X : Investment (year 0) ₹70 lakhs

Probability weights	0.30	0.40	0.30
Years	₹ lakhs	₹ lakhs	₹ lakhs
1	30	50	65
2	30	40	55
3	30	40	45

Project Y: Investment (year 0) ₹80 lakhs.

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Probability weighted	Annual cash flows through life
	₹ lakhs
0.20	40
0.50	45
0.30	50

- (a) Which project is better based on NPV, criterion with a discount rate of 10%?
- (b) Compute the standard deviation of the present value distribution and analyse the inherent risk of the projects.

Answer

(a) Calculation of NPV of XY Co.:

Project X		Cash flow	PVF	PV
Year				
1	$(30 \times 0.3) + (50 \times 0.4) + (65 \times 0.3)$	48.5	0.909	44.09
2	$(30 \times 0.3) + (40 \times 0.4) + (55 \times 0.3)$	41.5	0.826	34.28
3	$(30 \times 0.3) + (40 \times 0.4) + (45 \times 0.3)$	38.5	0.751	<u>28.91</u>
				<u>107.28</u>
	NPV: $(107.28 - 70.00) =$			(+) <u>37.28</u>
Project Y				
1-3	$(40 \times 0.2) + (45 \times 0.5) + (50 \times 0.3)$	45.5	2.486	<u>113.11</u>
	NPV $(113.11 - 80.00)$			(+) <u>33.11</u>

(b) Calculation of Standard deviation s

Project X			
Year			
1	$\sqrt{((30 - 48.5)^2 + (50 - 48.5)^2 + (65 - 48.5)^2)}$		24.83
2	$\sqrt{((30 - 41.5)^2 + (40 - 41.5)^2 + (55 - 41.5)^2)}$		17.80
3	$\sqrt{((30 - 38.5)^2 + (40 - 38.5)^2 + (45 - 38.5)^2)}$		10.81
Project Y			
	$\sqrt{(40 - 45.5)^2 + (45 - 45.5)^2 + (50 - 45.5)^2}$		7.12

As per Hillier's model

$$M = \sum_{i=0}^n (1+r)^{-i} M_i$$

$$s^2 = \sum_{i=0}^n (1+r)^{-2i} s_i^2$$

Hence

Project X

Year	$(1+r)^{-2i}$	s^2	
0	1.00	4,900	4,900
1	0.83	617	512
2	0.69	317	219
3	0.56	117	<u>66</u>
			<u>5,697</u>

Standard deviation = $\sqrt{5,697} = 75.48$

Project Y

Year			
0	1.00	6,400	6,400
1	0.83	51	42
2	0.69	51	35
3	0.56	51	<u>29</u>
			<u>6,506</u>

Standard deviation = $\sqrt{6,506} = 80.66$

Analysis: Project X is recommended because of higher NPV and lower standard deviation (risk of variability)

Question 19

Shivam Ltd. is considering two mutually exclusive projects A and B. Project A costs ₹36,000 and project B ₹ 30,000. You have been given below the net present value probability distribution for each project.

Project A		Project B	
NPV estimates (₹)	Probability	NPV estimates (₹)	Probability
15,000	0.2	15,000	0.1

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12,000	0.3	12,000	0.4
6,000	0.3	6,000	0.4
3,000	0.2	3,000	0.1

- Compute the expected net present values of projects A and B.
- Compute the risk attached to each project i.e. standard deviation of each probability distribution.
- Compute the profitability index of each project.
- Which project do you recommend? State with reasons.

Answer

- Statement showing computation of expected net present value of Projects A and B :

Project A			Project B		
NPV Estimate (₹)	Probability	Expected Value	NPV Estimate	Probability	Expected Value
15,000	0.2	3,000	15,000	0.1	1,500
12,000	0.3	3,600	12,000	0.4	4,800
6,000	0.3	1,800	6,000	0.4	2,400
3,000	0.2	600	3,000	0.1	300
	1.0	EV = 9,000		1.0	EV = 9,000

- Computation of Standard deviation of each project

Project A

P	X	(X – EV)	P (X-EV) ²
0.2	15,000	6,000	72,00,000
0.3	12,000	3,000	27,00,000
0.3	6,000	- 3,000	27,00,000
0.2	3,000	- 6,000	72,00,000
			<u>Variance = 1,98,00,000</u>

Standard Deviation of Project A = $\sqrt{1,98,00,000} = ₹4,450$

Project B

P	X	(X – EV)	P (X-EV) ²
0.1	15,000	6,000	36,00,000

0.4	12,000	3,000	36,00,000
0.4	6,000	- 3,000	36,00,000
0.1	3,000	- 6,000	<u>36,00,000</u>
			Variance = <u>1,44,00,000</u>

Standard Deviation of Project A = $\sqrt{1,44,00,000} = ₹3,795$

(iii) Computation of profitability of each project

Profitability index = Discount cash inflow / Initial outlay

$$\text{In case of Project A : PI} = \frac{9,000 + 36,000}{36,000} = \frac{45,000}{36,000} = 1.25$$

$$\text{In case of Project B : PI} = \frac{9,000 + 30,000}{30,000} = \frac{39,000}{30,000} = 1.30$$

- (iv)** Measurement of risk is made by the possible variation of outcomes around the expected value and the decision will be taken in view of the variation in the expected value where two projects have the same expected value, the decision will be the project which has smaller variation in expected value. In the selection of one of the two projects A and B, Project B is preferable because the possible profit which may occur is subject to less variation (or dispersion). Much higher risk is lying with project A.

Question 20

Aeroflot airlines is planning to procure a light commercial aircraft for flying class clients at an investment of ₹50 lakhs. The expected cash flow after tax for next three years is as follows:

(₹ in lakh)					
Year 1		Year 2		Year 3	
<u>CFAT</u>	<u>Probability</u>	<u>CFAT</u>	<u>Probability</u>	<u>CFAT</u>	<u>Probability</u>
15	.1	15	.1	18	.2
18	.2	20	.3	22	.5
22	.4	30	.4	35	.2
35	.3	45	.2	50	.1

The company wishes to consider all possible risk factors relating to an airline.

The company wants to know-

- the expected NPV of this proposal assuming independent probability distribution with 6 per cent risk free rate of interest, and
- the possible deviation on expected values

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Answer

(i) Determination of expected CFAT

₹ in lakh								
Year-1			Year-2			Year - 3		
CFAT	P ₁	Cash flow	CFAT	P ₂	Cash flow	CFAT	P ₃	Cash flow
15	0.1	1.5	15	0.1	1.5	18	0.2	3.6
18	0.2	3.6	20	0.3	6	22	0.5	11
22	0.4	8.8	30	0.4	12	35	0.2	7
35	0.3	10.5	45	0.2	9	50	0.1	5
		<u>CF₁ 24.4</u>			<u>CF₂ 28.5</u>			<u>CF₃ 26.6</u>
CFAT (₹ in lakh)			PV factor @ 6%			Total PV (₹ in lakh)		
24.4			0.943			23.009		
28.5			0.890			25.365		
26.6			0.840			<u>22.344</u>		
						70.718		
			Less Cash flow			<u>50.000</u>		
			= NPV			<u>20.718</u>		

(ii) Determination of Standard deviation for each year

Year 1

$(CF_1 - \overline{CF}_1)^2$	$(CF_1 - \overline{CF}_1)^2$	P ₁	
$(15-24.4)^2$	88.36	0.1	8.836
$(18-24.4)^2$	40.96	0.2	8.192
$(22-24.4)^2$	5.76	0.4	2.304
$(35-24.4)^2$	112.36	0.3	<u>33.708</u>
			<u>53.04</u>

$$\sigma = \sqrt{53.04} = 7.282$$

Year 2

$(CF_2 - \overline{CF}_2)^2$	$(CF_2 - \overline{CF}_2)^2$	P ₂	
$(15-28.5)^2$	182.25	0.1	18.225
$(20-28.5)^2$	72.25	0.3	21.675

$(30-28.5)^2$	2.25	0.4	0.9
$(45-28.5)^2$	272.25	0.2	<u>54.45</u>
			<u>95.25</u>

$$\sigma = \sqrt{95.25} = 9.76$$

Year -3

$(CF_3 - \overline{CF_3})^2$	$(CF_3 - \overline{CF_3})^2$	P_3	
$(18-26.6)^2$	73.96	0.2	14.792
$(22-26.6)^2$	21.16	0.5	10.58
$(35-26.6)^2$	70.56	0.2	14.112
$(50-26.6)^2$	547.56	0.1	<u>54.756</u>
			<u>94.24</u>

$$\sigma = \sqrt{94.24} = 9.70$$

Standard deviation of the expected Values

$$\sqrt{\sum_{t=1}^n \frac{\sigma_t}{(1+i)^{2t}}}$$

$$\sigma = \sqrt{\frac{7.282}{(1.06)^2} + \frac{9.76}{(1.06)^4} + \frac{9.7}{(1.06)^6}}$$

$$\sigma = \sqrt{6.48 + 7.73 + 6.84} = \sqrt{21.05} = 4.588$$

Question 21

Following are the estimates of the net cash flows and probability of a new project of M/s X Ltd.:

	Year	P=0.3	P=0.5	P=0.2
Initial investment	0	4,00,000	4,00,000	4,00,000
Estimated net after tax cash inflows per year	1 to 5	1,00,000	1,10,000	1,20,000
Estimated salvage value (after tax)	5	20,000	50,000	60,000

Required rate of return from the project is 10%. Find:

- The expected NPV of the project.
- The best case and the worst case NPVs.

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- (iii) The probability of occurrence of the worst case if the cash flows are perfectly dependent overtime and independent overtime.
- (iv) Standard deviation and coefficient of variation assuming that there are only three streams of cash flow, which are represented by each column of the table with the given probabilities.
- (v) Coefficient of variation of X Ltd. on its average project which is in the range of 0.95 to 1.0. If the coefficient of variation of the project is found to be less risky than average, 100 basis points are deducted from the Company's cost of Capital

Should the project be accepted by X Ltd?

Answer

(a) (i) Expected cash flows:-

Year			Net cash flows	P.V.	PV. @ 10%
0	(4,00,000 x 1)	=	(-)4,00,000	1.000	(-)4,00,000
1 to 4	(1,00,000x0.3+1,10,000x0.5 + 1,20,000 x 0.2)	=	1,09,000	3.170	3,45,530
5	[1,09,000 + (20,000 x 0.3 + 50,000 x 0.5 + 60,000 x 0.2)]	=	1,52,000	0.621	94,392
			NPV=		39,922

(ii) ENPV of the worst case

$1,00,000 \times 3.790 = ₹3,79,000$ (Students may have 3.791 also the values will change accordingly)

$20,000 \times 0.621 = ₹12,420/-$

$ENPV = (-)4,00,000 + 3,79,000 + 12,420 = (-)₹8,580/-$

ENPV of the best case

$ENPV = (-)4,00,000 + 1,20,000 \times 3.790 + 60,000 \times 0.621 = ₹92,060/-$

(iii) (a) Required probability = 0.3

(b) Required probability = $(0.3)^5 = 0.00243$

(iv) The base case NPV = $(-)4,00,000 + (1,10,000 \times 3.79) + (50,000 \times 0.621)$
 $= ₹47,950/-$

$ENPV = 0.30 \times (-) 8580 + 0.5 \times 47950 + 92060 \times 0.20$
 $= ₹39,813/-$

Therefore,

$$s\text{ENPV} = \sqrt{0.3(-8580 - 39,813)^2 + 0.5(47950 - 39,813)^2 + 0.2(92,060 - 39,813)^2}$$

$$= ₹35,800/-$$

Therefore, CV = 35,800/39,813 = 0.90

(v) Risk adjusted out of cost of capital of X Ltd. = 10% - 1% = 9%.

NPV

Year	Expected net cash flow	PV @ 9%	
0	(-)4,00,000	1.000	(-)4,00,000
1 to 4	1,09,000	3.240	3,53,160
5	1,52,000	0.650	<u>98,800</u>
		ENPV =	<u>51,960</u>

Therefore, the project should be accepted.

Question 22

XYZ Ltd. is considering a project for which the following estimates are available:

	₹
Initial Cost of the project	10,00,000
Sales price/unit	60
Cost/unit	40
Sales volumes	
Year 1	20000 units
Year 2	30000 units
Year 3	30000 units

Discount rate is 10% p.a.

You are required to measure the sensitivity of the project in relation to each of the following parameters:

- (a) Sales Price/unit
- (b) Unit cost
- (c) Sales volume
- (d) Initial outlay and
- (e) Project lifetime

Taxation may be ignored.

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Answer

Calculation of NPV

$$\begin{aligned}\text{NPV} &= -10,00,000 + \frac{20,000 \times 20}{1.1} + \frac{30,000 \times 20}{1.21} + \frac{30,000 \times 20}{1.331} \\ &= -10,00,000 + 3,63,636 + 4,95,868 + 4,50,789 \\ &= 13,10,293 - 10,00,000 \\ &= ₹3,10,293/-\end{aligned}$$

Measurement of sensitivity is as follows:

(a) Sales Price:-

Let the sale price/Unit be S so that the project would break even with 0 NPV.

$$-10,00,000 = \frac{20,000(S - 40)}{1.1} + \frac{30,000(S - 40)}{1.21} + \frac{30,000(S - 40)}{1.331}$$

$$S - 40 = 10,00,000/65,514$$

$$S - 40 = ₹15.26$$

$$S = ₹55.26 \text{ which represents a fall of } (60 - 55.26)/60$$

$$\text{Or } 0.079 \text{ or } 7.9\%$$

Alternative Method

$$\frac{10,00,000 \times 20}{13,10,293} = ₹15.26$$

$$S = ₹40 + ₹15.26$$

$$= ₹55.26$$

Alternative Solution

If sale Price decreased by say 10%, then NPV (at Sale Price of ₹ 60 – ₹ 6 = ₹ 54)

$$\text{NPV} = -10,00,000 + \frac{20,000 \times 14}{(1.1)^1} + \frac{30,000 \times 14}{(1.1)^2} + \frac{30,000 \times 14}{(1.1)^3}$$

$$= -10,00,000 + 2,54,545 + 3,47,107 + 3,15,552$$

$$= -82,796$$

$$\text{NPV decrease (\%)} = \frac{3,10,293 - (-82,796)}{3,10,293} \times 100 = 126.68\%$$

(b) Unit Cost:-

If sales price = ₹ 60 the cost price required to give a margin of ₹15.26 is (₹60 – ₹15.26) or ₹44.74 which would represent a rise of 11.85%

$$\text{i.e., } \frac{44.74 - 40}{40} \times 100 = 11.85\%$$

Alternative Solution

If unit cost increased by say 10%. The new NPV will be as follows:

$$\begin{aligned} \text{NPV} &= -10,00,000 + \frac{20000 \times 16}{(1.1)^1} + \frac{30000 \times 16}{(1.1)^2} + \frac{30000 \times 16}{(1.1)^3} \\ &= -10,00,000 + 2,90,909 + 3,96,694 + 3,60,631 \\ &= 48,234 \end{aligned}$$

$$\text{NPV decrease (\%)} = \frac{3,10,293 - (48,234)}{3,10,293} \times 100 = 84.46\%$$

(c) Sales volume:-

The requisite percentage fall is:-

$$3,10,293 / 13,10,293 \times 100 = 23.68\%$$

Alternative Solution

If sale volume decreased by say 10%. The new NPV will be as follows:

$$\begin{aligned} \text{NPV} &= -10,00,000 + \frac{18000 \times 20}{(1.1)^1} + \frac{27000 \times 20}{(1.1)^2} + \frac{27000 \times 20}{(1.1)^3} \\ &= -10,00,000 + 3,27,272 + 4,46,281 + 4,05,710 \\ &= 1,79,263 \end{aligned}$$

$$\text{NPV decrease (\%)} = \frac{3,10,293 - 1,79,263}{3,10,293} \times 100 = 42.22\%$$

(d) Since PV of inflows remains at ₹13,10,293 the initial outlay must also be the same.

$$\text{Percentage rise} = 3,10,293 / 10,00,000 \times 100 = 31.03\%$$

Alternative Solution

If initial outlay increased by say 10%. The new NPV will be as follows:

$$\begin{aligned} \text{NPV} &= -11,00,000 + \frac{20000 \times 20}{(1.1)^1} + \frac{30000 \times 20}{(1.1)^2} + \frac{30000 \times 20}{(1.1)^3} \\ &= -11,00,000 + 3,63,636 + 4,95,868 + 4,50,789 = 2,10,293 \end{aligned}$$

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$$\text{NPV decrease (\%)} = \frac{3,10,293 - 2,10,293}{3,10,293} \times 100 = 32.22\%$$

(e) Present value for 1st two years.

$$= -10,00,000 + 4,00,000 \times 0.909 + 6,00,000 \times 0.826$$

$$= -10,00,000 + 3,63,600 + 4,95,600$$

$$= -10,00,000 + 8,59,200$$

$$= -1,40,800$$

\ The project needs to run for some part of the third year so that the present value of return is ₹1,40,800. It can be computed as follows:

(i) $30,000 \text{ units} \times ₹ 20 \times 0.751 = ₹4,50,600$

(ii) Per day Production in (₹) assuming a year of 360 days =

$$\frac{₹ 4,50,600}{360} = ₹ 1,252$$

(iii) Days needed to recover ₹1,40,800 = $\frac{₹ 1,40,800}{₹ 1,252} = 112$

Thus, if the project runs for 2 years and 112 days then break even would be achieved.

Question 23

From the following details relating to a project, analyse the sensitivity of the project to changes in initial project cost, annual cash inflow and cost of capital:

Initial Project Cost (₹)	1,20,000
Annual Cash Inflow (₹)	45,000
Project Life (Years)	4
Cost of Capital	10%

To which of the three factors, the project is most sensitive? (Use annuity factors: for 10% 3.169 and 11% ... 3.109).

Answer

CALCULATION OF NPV

	₹
PV of cash inflows (₹ 45,000 x 3.169)	1,42,605
Initial Project Cost	<u>1,20,000</u>
NPV	<u>22,605</u>

If initial project cost is varied adversely by 10%*

NPV (Revised) (₹ 1,42,605 - ₹ 1,32,000) ₹ 10,605

Change in NPV (₹ 22,605 – ₹ 10,605) / ₹ 22,605 i.e 53.08 %

If annual cash inflow is varied adversely by 10%*

Revised annual inflow ₹ 40,500

NPV (Revised) (₹ 40,500 x 3.169) – (₹ 1,20,000) (+) ₹ 8,345

Change in NPV (₹ 22,605 – ₹ 8,345) / ₹ 22,605 63.08 %

If cost of capital is varied adversely by 10%*

NPV (Revised) (₹ 45,000 x 3.109) – ₹ 1,20,000 (+) ₹ 19,905

Change in NPV (₹ 22,605 – ₹ 19,905) / ₹ 22,605 11.94 %

Conclusion: Project is most sensitive to 'annual cash inflow'.

*Note: Students may please note that they may assume any other percentage rate other than 10 % say 15% , 20 % 25 % etc.

Question 24

Red Ltd. is considering a project with the following Cash flows:

₹			
Years	Cost of Plant	Recurring Cost	Savings
0	10,000		
1		4,000	12,000
2		5,000	14,000

The cost of capital is 9%. Measure the sensitivity of the project to changes in the levels of plant value, running cost and savings (considering each factor at a time) such that the NPV becomes zero. The P.V. factor at 9% are as under:

<u>Year</u>	<u>Factor</u>
0	1
1	0.917
2	0.842

Which factor is the most sensitive to affect the acceptability of the project?

Answer

P.V. of Cash Flows

Year 1	Running Cost	₹ 4,000 x 0.917	= (₹ 3,668)
	Savings	₹ 12,000 x 0.917	= ₹ 11,004
Year 2	Running Cost	₹ 5,000 x 0.842	= (₹ 4,210)

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	Savings	₹ 14,000 x 0.842	= ₹ 11,788
			₹ 14,914
Year 0	Less: P.V. of Cash Outflow	₹ 10,000 x 1	₹ 10,000
	NPV		<u>₹ 4,914</u>

Sensitivity Analysis

- (i) Increase of Plant Value by ₹ 4,914

$$\backslash \frac{4,914}{10,000} \times 100 = 49.14\%$$

- (ii) Increase of Running Cost by ₹ 4,914

$$\frac{4,914}{3,668 + 4,210} = \frac{4,914}{7,878} \times 100 = 62.38\%$$

- (iii) Fall in Saving by ₹ 4,914

$$\frac{4,914}{11,004 + 11,788} = \frac{4,914}{22,792} \times 100 = 21.56\%$$

Hence, savings factor is the most sensitive to affect the acceptability of the project.

Alternative Solution

P.V. of Cash Flows

Year 1	Running Cost	₹ 4,000 x 0.917	= (₹ 3,668)
	Savings	₹ 12,000 x 0.917	= ₹ 11,004
Year 2	Running Cost	₹ 5,000 x 0.842	= (₹ 4,210)
	Savings	₹ 14,000 x 0.842	= ₹ 11,788
			₹ 14,914
Year 0	Less: P.V. of Cash Outflow	₹ 10,000 x 1	₹ 10,000
	NPV		<u>₹ 4,914</u>

Sensitivity Analysis

- (i) If the initial project cost is varied adversely by say 10%*.

$$\text{NPV (Revised)} (\text{₹ } 4,914 - \text{₹ } 1,000) = \text{₹ } 3,914$$

$$\text{Change in NPV } \frac{\text{₹ } 4,914 - \text{₹ } 3,914}{\text{₹ } 4,914} = 20.35\%$$

- (ii) If Annual Running Cost is varied by say 10%*.

$$\text{NPV (Revised)} (\text{₹ } 4,914 - \text{₹ } 400 \times 0.917 - \text{₹ } 500 \times 0.843)$$

$$= ₹ 4,914 - ₹ 367 - ₹ 421 = ₹ 4,126$$

$$\text{Change in NPV} = \frac{₹ 4,914 - ₹ 4,126}{₹ 4,914} = 16.04\%$$

(iii) If Saving is varied by say 10%*.

$$\text{NPV (Revised)} (₹ 4,914 - ₹ 1,200 \times 0.917 - ₹ 1,400 \times 0.843)$$

$$= ₹ 4,914 - ₹ 1,100 - ₹ 1,180 = ₹ 2,634$$

$$\text{Change in NPV} = \frac{₹ 4,914 - ₹ 2,634}{₹ 4,914} = 46.40\%$$

Hence, savings factor is the most sensitive to affect the acceptability of the project.

* Any percentage of variation other than 10% can also be assumed.

Question 25

XY Ltd. has under its consideration a project with an initial investment of ₹ 1,00,000. Three probable cash inflow scenarios with their probabilities of occurrence have been estimated as below:

Annual cash inflow (₹)	20,000	30,000	40,000
Probability	0.1	0.7	0.2

The project life is 5 years and the desired rate of return is 20%. The estimated terminal values for the project assets under the three probability alternatives, respectively, are ₹ 0, 20,000 and 30,000.

You are required to:

- Find the probable NPV;
- Find the worst-case NPV and the best-case NPV; and
- State the probability occurrence of the worst case, if the cash flows are perfectly positively correlated over time.

Answer

The expected cash flows of the project are as follows:

Year	Pr = 0.1	Pr = 0.7	Pr = 0.2	Total
	₹	₹	₹	₹
0	-10,000	-70,000	-20,000	-1,00,000
1	2,000	21,000	8,000	31,000
2	2,000	21,000	8,000	31,000
3	2,000	21,000	8,000	31,000

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4	2,000	21,000	8,000	31,000
5	2,000	21,000	8,000	31,000
5	0	14,000	6,000	20,000

- (i) NPV based on expected cash flows would be as follows:

$$= -₹ 1,00,000 + \frac{₹ 31,000}{(1+0.20)^1} + \frac{₹ 31,000}{(1+0.20)^2} + \frac{₹ 31,000}{(1+0.20)^3} + \frac{₹ 31,000}{(1+0.20)^4} + \frac{₹ 31,000}{(1+0.20)^5} + \frac{₹ 20,000}{(1+0.20)^5}$$

$$= -₹ 1,00,000 + ₹ 25,833.33 + ₹ 21,527.78 + ₹ 17,939.81 + ₹ 14,949.85 + ₹ 12,458.20 + ₹ 8,037.55$$

$$\text{NPV} = ₹ 746.52$$

- (ii) For the worst case, the cash flows from the cash flow column farthest on the left are used to calculate NPV

$$= -₹ 100,000 + \frac{\text{Rs.}20,000}{(1+0.20)^1} + \frac{\text{Rs.}20,000}{(1+0.20)^2} + \frac{\text{Rs.}20,000}{(1+0.20)^3} + \frac{\text{Rs.}20,000}{(1+0.20)^4} + \frac{\text{Rs.}20,000}{(1+0.20)^5}$$

$$= -₹ 100,000 + ₹ 16,666.67 + ₹ 13,888.89 + ₹ 11,574.07 + ₹ 9,645.06 + ₹ 8,037.76$$

$$\text{NPV} = -₹ 40,187.76$$

For the best case, the cash flows from the cash flow column farthest on the right are used to calculate NPV

$$= -₹ 100,000 + \frac{₹ 40,000}{(1+0.20)^1} + \frac{₹ 40,000}{(1+0.20)^2} + \frac{₹ 40,000}{(1+0.20)^3} + \frac{₹ 40,000}{(1+0.20)^4} + \frac{₹ 40,000}{(1+0.20)^5} + \frac{₹ 30,000}{(1+0.20)^5}$$

$$= -₹ 1,00,000 + ₹ 33,333.33 + ₹ 27,777.78 + ₹ 23,148.15 + ₹ 19,290.12 + ₹ 16,075.10 + ₹ 12,056.33$$

$$\text{NPV} = ₹ 31,680.81$$

- (iii) If the cash flows are perfectly dependent, then the low cash flow in the first year will mean a low cash flow in every year. Thus the possibility of the worst case occurring is the probability of getting ₹ 2,000 net cash flow in year 1 or 10%.

Question 26

The Textile Manufacturing Company Ltd., is considering one of two mutually exclusive proposals, Projects M and N, which require cash outlays of ₹ 8,50,000 and ₹ 8,25,000 respectively. The certainty-equivalent (C.E) approach is used in incorporating risk in capital budgeting decisions. The current yield on government bonds is 6% and this is used as the risk free rate. The expected net cash flows and their certainty equivalents are as follows:

Project M			Project N	
Year-end	Cash Flow ₹	C.E.	Cash Flow ₹	C.E.
1	4,50,000	0.8	4,50,000	0.9
2	5,00,000	0.7	4,50,000	0.8
3	5,00,000	0.5	5,00,000	0.7

Present value factors of Re. 1 discounted at 6% at the end of year 1, 2 and 3 are 0.943, 0.890 and 0.840 respectively.

Required:

- (i) Which project should be accepted?
- (ii) If risk adjusted discount rate method is used, which project would be appraised with a higher rate and why?

Answer

(i) Statement Showing the Net Present Value of Project M

Year end	Cash Flow (₹) (a)	C.E. (b)	Adjusted Cash flow (₹) (c) = (a) × (b)	Present value factor at 6% (d)	Total Present value (₹) (e) = (c) × (d)
1	4,50,000	0.8	3,60,000	0.943	3,39,480
2	5,00,000	0.7	3,50,000	0.890	3,11,500
3	5,00,000	0.5	2,50,000	0.840	<u>2,10,000</u>
					8,60,980
Less: Initial Investment					<u>8,50,000</u>
Net Present Value					<u>10,980</u>

Statement Showing the Net Present Value of Project N

Year end	Cash Flow (₹) (a)	C.E. (b)	Adjusted Cash flow (₹) (c) = (a) × (b)	Present value factor (d)	Total Present value (₹) (e) = (c) × (d)
1	4,50,000	0.9	4,05,000	0.943	3,81,915
2	4,50,000	0.8	3,60,000	0.890	3,20,400
3	5,00,000	0.7	3,50,000	0.840	<u>2,94,000</u>
					9,96,315

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Less: Initial Investment			<u>8,25,000</u>
Net Present Value			<u>1,71,315</u>

Decision : Since the net present value of Project N is higher, so the project N should be accepted.

- (ii) Certainty - Equivalent (C.E.) Co-efficient of Project M (2.0) is lower than Project N (2.4). This means Project M is riskier than Project N as "higher the riskiness of a cash flow, the lower will be the CE factor". If risk adjusted discount rate (RADR) method is used, Project M would be analysed with a higher rate.

RADR is based on the premise that riskiness of a proposal may be taken care of, by adjusting the discount rate. The cash flows from a more risky proposal should be discounted at a relatively higher discount rate as compared to other proposals whose cash flows are less risky. Any investor is basically risk averse. However, he may be ready to take risk provided he is rewarded for undertaking risk by higher returns. So, more risky the investment is, the greater would be the expected return. The expected return is expressed in terms of discount rate which is also the minimum required rate of return generated by a proposal if it is to be accepted. Therefore, there is a positive correlation between risk of a proposal and the discount rate.

Question 27

Determine the risk adjusted net present value of the following projects:

	X	Y	Z
Net cash outlays (₹)	2,10,000	1,20,000	1,00,000
Project life	5 years	5 years	5 years
Annual Cash inflow (₹)	70,000	42,000	30,000
Coefficient of variation	1.2	0.8	0.4

The Company selects the risk-adjusted rate of discount on the basis of the coefficient of variation:

Coefficient of Variation	Risk-Adjusted Rate of Return	P.V. Factor 1 to 5 years At risk adjusted rate of discount
0.0	10%	3.791
0.4	12%	3.605
0.8	14%	3.433
1.2	16%	3.274

1.6	18%	3.127
2.0	22%	2.864
More than 2.0	25%	2.689

Answer**Statement showing the determination of the risk adjusted net present value**

Projects	Net cash outlays	Coefficient of variation	Risk adjusted discount rate	Annual cash inflow	PV factor 1-5 years	Discounted cash inflow	Net present value
	₹			₹		₹	₹
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii) = (v) × (vi)	(viii) = (vii) - (ii)
X	2,10,000	1.20	16%	70,000	3.274	2,29,180	19,180
Y	1,20,000	0.80	14%	42,000	3.433	1,44,186	24,186
Z	1,00,000	0.40	12%	30,000	3.605	1,08,150	8,150

Question 28

New Projects Ltd. is evaluating 3 projects, P-I, P-II, P-III. Following information is available in respect of these projects:

	P-I	P-II	P-III
Cost	₹15,00,000	₹11,00,000	₹19,00,000
Inflows-Year 1	6,00,000	6,00,000	4,00,000
Year 2	6,00,000	4,00,000	6,00,000
Year 3	6,00,000	5,00,000	8,00,000
Year 4	6,00,000	2,00,000	12,00,000
Risk Index	1.80	1.00	0.60

Minimum required rate of return of the firm is 15% and applicable tax rate is 40%. The risk free interest rate is 10%.

Required:

- (i) Find out the risk-adjusted discount rate (RADR) for these projects.

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(ii) Which project is the best?

Answer

- (i) The risk free rate of interest and risk factor for each of the projects are given. The risk adjusted discount rate (RADR) for different projects can be found on the basis of CAPM as follows:

$$\text{Required Rate of Return} = I_{RF} + (k_e - I_{RF}) \text{ Risk Factor}$$

$$\text{For P-I : RADR} = 0.10 + (0.15 - 0.10) 1.80 = 19\%$$

$$\text{For P-II : RADR} = 0.10 + (0.15 - 0.10) 1.00 = 15\%$$

$$\text{For P-III : RADR} = 0.10 + (0.15 - 0.10) 0.60 = 13\%$$

- (ii) The three projects can now be evaluated at 19%, 15% and 13% discount rate as follows:

Project P-I

Annual Inflows	₹ 6,00,000
PVAF (19 %, 4)	2.639
PV of Inflows (₹ 6,00,000 x 2.639)	₹ 15,83,400
Less: Cost of Investment	<u>₹ 15,00,000</u>
Net Present Value	<u>₹ 83,400</u>

Project P-II

Year	Cash Inflow (₹)	PVF (15%,n)	PV (₹)
1	6,00,000	0.870	5,22,000
2	4,00,000	0.756	3,02,400
3	5,00,000	0.658	3,29,000
4	2,00,000	0.572	<u>1,14,400</u>
Total Present Value			12,67,800
Less: Cost of Investment			<u>11,00,000</u>
Net Present Value			<u>1,67,800</u>

Project P-III

Year	Cash Inflow (₹)	PVF (13%,n)	PV (₹)
1	4,00,000	0.885	3,54,000
2	6,00,000	0.783	4,69,800
3	8,00,000	0.693	5,54,400
4	12,00,000	0.613	<u>7,35,600</u>

Total Present Value			21,13,800
Less: Cost of Investment			<u>19,00,000</u>
Net Present Value			<u>2,13,800</u>

Project P-III has highest NPV. So, it should be accepted by the firm

Question 29

A firm has projected the following cash flows from a project under evaluation:

Year	₹ lakhs
0	(70)
1	30
2	40
3	30

The above cash flows have been made at expected prices after recognizing inflation. The firm's cost of capital is 10%. The expected annual rate of inflation is 5%.

Show how the viability of the project is to be evaluated.

Answer

It is stated that the cash flows have been adjusted for inflation; hence they are "nominal". The cost of capital or discount rate is "real". In order to be compatible, the cash flows should be converted into "real flow". This is done as below:

Year	Nominal cash flows	Adjusted Inflation* factor	Real cash flows	PVF @ 10%	PV of cash flows
0	(70)	-	(70)	1.000	(70)
1	30	0.952	28.56	0.909	25.96
2	40	0.907	36.28	0.826	29.97
3	30	0.864	25.92	0.751	<u>19.47</u>
				Total	75.40
Less: Cash out flow					<u>70.00</u>
NPV (+)					<u>5.40</u>

* $1/1.05$; $1/(1.05)^2$; $1/(1.05)^3$;

Advise: With positive NPV, the project is financially viable.

Alternatively, instead of converting cash flows into real terms, the discount rate can be converted into nominal rate. Result will be the same.

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An alternative solution is presented herewith

Alternative solution:

Year	Nominal cash flows	PVF @ 10% adjusted by the inflation factor i.e. 5%*	PV of cash flows
1	30	0.866	25.98
2	40	0.749	29.96
3	30	0.649	<u>19.47</u>
	Cash inflow		75.41
	Less: Cash out flow		<u>70.00</u>
	Net present value		<u>5.41</u>

$$* \frac{0.909}{1.05} = 0.866, \frac{0.826}{1.1025} = 0.749, \frac{0.751}{1.1576} = 0.649$$

Advise: With positive NPV, the project is financially viable.

Question 30

Shashi Co. Ltd has projected the following cash flows from a project under evaluation:

Year	0	1	2	3
₹ (in lakhs)	(72)	30	40	30

The above cash flows have been made at expected prices after recognizing inflation. The firm's cost of capital is 10% . The expected annual rate of inflation is 5%. Show how the viability of the project is to be evaluated. PVF at 10% for 1-3 years are 0.909, 0.826 and 0.751.

Answer

Here the given cash flows have to be adjusted for inflation. Alternatively, the discount rate can be converted into nominal rate, as follows:-

$$\text{Year 1} = \frac{0.909}{1.05} = 0.866; \quad \text{Year 2} = \frac{0.826}{(1.05)^2} \text{ or } \frac{0.826}{1.1025} = 0.749$$

$$\text{Year 3} = \frac{0.751}{(1.05)^3} = \frac{0.751}{1.1576} = 0.649$$

Year	Nominal Cash Flows (₹ in lakhs)	Adjusted PVF as above	PV of Cash Flows (₹ in lakhs)
1	30	0.866	25.98
2	40	0.749	29.96

3	30	0.649	<u>19.47</u>
	Cash Inflow		75.41
	Less: Cash Outflow		<u>72.00</u>
	Net Present Value		<u>3.41</u>

With positive NPV, the project is financially viable.

Alternative Solution

Assumption: The cost of capital given in the question is "Real".

Nominal cost of capital = $(1.10)(1.05) - 1 = 0.155 = 15.50\%$

DCF Analysis of the project

				(₹ Lakhs)
	Period	PVF @15.50%	CF	PV
Investment	0	1	-72	-72.00
Operation	1	0.866	30	+25.98
---do---	2	0.750	40	+30.00
---do---	3	0.649	30	<u>+19.47</u>
NPV				<u>+3.45</u>

The proposal may be accepted as the NPV is positive.

Question 31

A firm has an investment proposal, requiring an outlay of ₹80,000. The investment proposal is expected to have two years economic life with no salvage value. In year 1, there is a 0.4 probability that cash inflow after tax will be ₹50,000 and 0.6 probability that cash inflow after tax will be ₹60,000. The probability assigned to cash inflow after tax for the year 2 is as follows:

The cash inflow year 1	₹ 50,000	₹ 60,000
The cash inflow year 2	Probability	Probability
	₹ 24,000 0.2	₹ 40,000 0.4
	₹ 32,000 0.3	₹ 50,000 0.5
	₹ 44,000 0.5	₹ 60,000 0.1

The firm uses a 10% discount rate for this type of investment.

Required:

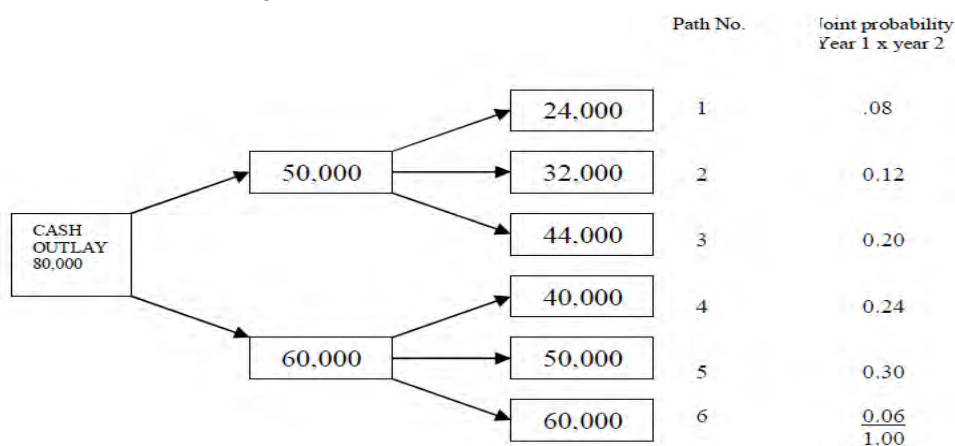
- Construct a decision tree for the proposed investment project and calculate the expected net present value (NPV).

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- (ii) What net present value will the project yield, if worst outcome is realized? What is the probability of occurrence of this NPV?
- (iii) What will be the best outcome and the probability of that occurrence?
- (iv) Will the project be accepted?
- (Note: 10% discount factor 1 year 0.909; 2 year 0.826)

Answer

- (i) The decision tree diagram is presented in the chart, identifying various paths and outcomes, and the computation of various paths/outcomes and NPV of each path are presented in the following tables:



The Net Present Value (NPV) of each path at 10% discount rate is given below:

Path	Year 1 Cash Flows (₹)	Year 2 Cash Flows (₹)	Total Cash Inflows (PV) (₹)	Cash Inflows NPV (₹)
1	50,000 × .909 = 45,450	24,000 × .826 = 19,824	65,274	80,000 (–) 14,726
2	45,450	32,000 × .826 = 26,432	71,882	80,000 (–) 8,118
3	45,450	44,000 × .826 = 36,344	81,794	80,000 1,794
4	60,000 × .909 = 54,540	40,000 × .826 = 33,040	87,580	80,000 7,580
5	54,540	50,000 × .826 = 41,300	95,840	80,000 15,840

6	54,540	60,000 × .826 49,560	=	1,04,100	80,000	24,100
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Statement showing Expected Net Present Value

₹			
z	NPV(₹)	Joint Probability	Expected NPV
1	–14,726	0.08	–1,178.08
2	–8,118	0.12	–974.16
3	1,794	0.20	358.80
4	7,580	0.24	1,819.20
5	15,840	0.30	4,752.00
6	24,100	0.06	1,446.00
			<u>6,223.76</u>

Conclusions:

- (ii) If the worst outcome is realized the project will yield NPV of – ₹ 14,726. The probability of occurrence of this NPV is 8% and a loss of ₹ 1,178 (path 1).
- (iii) The best outcome will be path 5 when the NPV is at ₹ 15,840. The probability of occurrence of this NPV is 30% and a expected profit of ₹ 4,752.
- (iv) The project should be accepted because the expected NPV is positive at ₹ 6,223.76 based on joint probability.

Question 32

Big Oil is wondering whether to drill for oil in Westchester Country. The prospectus is as follows:

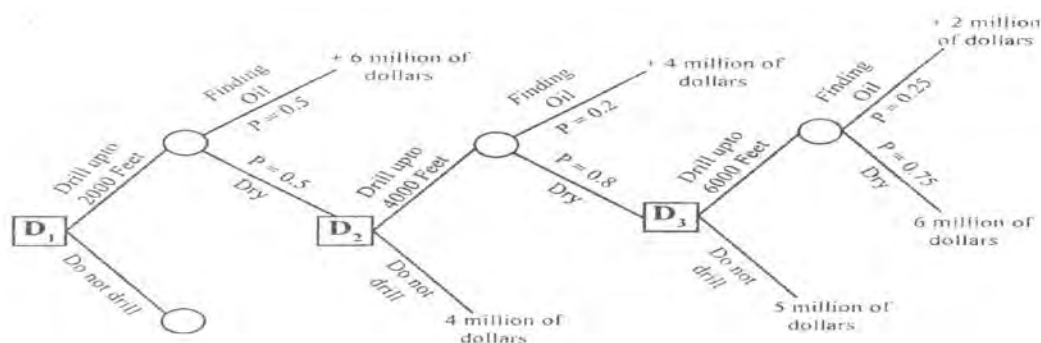
Depth of Well Feet	Total Cost Millions of Dollars	Cumulative Probability of Finding Oil	PV of Oil (If found) Millions of Dollars
2,000	4	0.5	10
4,000	5	0.6	9
6,000	6	0.7	8

Draw a decision tree showing the successive drilling decisions to be made by Big Oil. How deep should it be prepared to drill?

Answer

The given data is easily represented by the following decision tree diagram:

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There are three decision points in the tree indicated by D_1 , D_2 and D_3 .

Using rolling back technique, we shall take the decision at decision point D_3 first and then use it to arrive decision at a decisions point D_2 and then use it to arrive decision at a decision point D_1 .

Statement showing the evaluation of decision at Decision Point D_3

	Decision	Event	Probability	P.V. of Oil (if found) (Millions of dollars)	Expected P.V. of Oil (if found) (Millions of dollars)
1.	Drill upto 6,000 feet	Finding Oil	0.25	+ 2	0.50
		Dry	0.75	- 6	- 4.50
		(Refer to working note)			
					<u>- 4.00</u>
2.	Do not drill				<u>- 5.00</u>

Since the Expected P.V. of Oil (if found) on drilling upto 6,000 feet – 4 millions of dollars is greater than the cost of not drilling – 5 millions of dollars. Therefore, Big Oil should drill upto 6,000 feet.

Statement showing the evaluation of decision at Decision Point D_2

	Decision	Event	Probability	P.V. of Oil (if found) (Millions of dollars)	Expected P.V. of Oil (if found) (Millions of dollars)
1.	Drill upto	Finding Oil	0.2	4	0.8
	4,000 feet	Dry	0.8	- 4	- 3.2
		(Refer to working note)			

2.	Do not drill				<u>- 2.4</u> <u>- 4</u>
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Since the Expected P.V. of Oil (if found) on drilling upto 4,000 feet – 2.4 millions of dollars is greater than the cost of not drilling – 4 millions of dollars. Therefore, Big Oil should drill upto 4,000 feet.

Statement showing the evaluation of decision at Decision Point D₁

	Decision	Event	Probability	P.V. of Oil (if found) (Millions of dollars)	Expected P.V. of Oil (if found) (Millions of dollars)
1.	Drill upto	Finding Oil	0.5	6	3.0
	2,000 feet	Dry (Refer to working note)	0.5	- 2.4	- 1.2
					<u>1.8</u>
2.	Do not drill				NIL

Since the Expected P.V. of Oil (if found) on drilling upto 2,000 feet is 1.8 millions of dollars (positive), Big Oil should drill upto 2,000 feet.

Working Notes:

Let x be the event of not finding oil at 2,000 feet and y be the event of not finding oil at 4,000 feet and z be the event of not finding oil at 6,000 feet.

We know, that,

$$P(x \text{ } \bar{C} \text{ } y) = P(x) \cdot P(y/x)$$

Where, $P(x \text{ } \bar{C} \text{ } y)$ is the joint probability of not finding oil at 2,000 feet and 4,000 feet, $P(x)$ is the probability of not finding oil at 2,000 feet and $P(y/x)$ is the probability of not finding oil at 4,000 feet, if the event x has already occurred.

$$\begin{aligned} P(x \text{ } \bar{C} \text{ } y) &= 1 - \text{Cumulative probability of finding oil at 4,000 feet} \\ &= 1 - 0.6 = 0.4 \end{aligned}$$

$$\begin{aligned} P(x) &= 1 - \text{Probability of finding oil at 2,000 feet} \\ &= 1 - 0.5 = 0.5 \end{aligned}$$

$$\text{Hence, } P(y/x) = \frac{P(x \text{ } \bar{C} \text{ } y)}{P(x)} = \frac{0.4}{0.5} = 0.8$$

Therefore, probability of finding oil between 2,000 feet to 4,000 feet = $1 - 0.8 = 0.2$ we know that

$$P(x \text{ } \bar{C} \text{ } y \text{ } \bar{C} \text{ } z) = P(x) \cdot P(y/x) \cdot P(z/x \text{ } \bar{C} \text{ } y)$$

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Where $P(x \cap y \cap z)$ is the joint probability of not finding oil at 2,000 feet, 4,000 feet and 6,000 feet, $P(x)$ and $P(y/x)$ are as explained earlier and $P(z/x \cap y)$ is the probability of not finding oil at 6,000 feet if the event x and y has already occurred.

$$\begin{aligned}P(x \cap y \cap z) &= 1 - \text{Cumulative probability of finding oil at 6,000 feet} \\&= 1 - 0.7 = 0.3\end{aligned}$$

$$P(z/x \cap y) = \frac{P(x \cap y \cap z)}{P(x) \cdot P(y/x)} = \frac{0.3}{0.5 \cdot 0.8} = \frac{0.3}{0.4} = 0.75$$

Therefore, probability of finding oil between 4,000 feet to 6,000 feet = $1 - 0.75 = 0.25$

Question 33

The total market value of the equity share of O.R.E. Company is ₹ 60,00,000 and the total value of the debt is ₹ 40,00,000. The treasurer estimate that the beta of the stock is currently 1.5 and that the expected risk premium on the market is 10 per cent. The treasury bill rate is 8 per cent.

Required:

- (1) What is the beta of the Company's existing portfolio of assets?
- (2) Estimate the Company's Cost of capital and the discount rate for an expansion of the company's present business.

Answer

$$(1) \beta_{\text{company}} = \beta_{\text{equity}} \times \frac{V_E}{V_0} + \beta_{\text{debt}} \times \frac{V_D}{V_0}$$

Note: Since β_{debt} is not given it is assumed that company debt capital is virtually riskless.

If company's debt capital is riskless than above relationship become:

$$\text{Here } \beta_{\text{equity}} = 1.5 \beta_{\text{assets}} = \beta_{\text{equity}} \frac{V_E}{V_0}$$

$$\beta_{\text{debt}} = 0$$

$$V_E = ₹ 60 \text{ lakhs.}$$

$$V_D = ₹ 40 \text{ lakhs.}$$

$$V_0 = ₹ 100 \text{ lakhs.}$$

$$\begin{aligned}\beta_{\text{company}} &= 1.5 \cdot \frac{₹ 60 \text{ lakhs}}{₹ 100 \text{ lakhs}} \\&= 0.9\end{aligned}$$

(2) Company's cost of capital = $b_8 + b_A \times \text{Risk premium}$

Where b_8 = Risk free rate of return

b_A = Beta of company assets

Therefore, company's cost of capital = $8\% + 0.9 \times 10 = 17\%$

In case of expansion of the company's present business, the same rate of return i.e. 17% will be used. However, in case of diversification into new business the risk profile of new business is likely to be different. Therefore, different discount factor has to be worked out for such business.

Question 34

Jumble Consultancy Group has determined relative utilities of cash flows of two forthcoming projects of its client company as follows :

Cash Flow in ₹	-15000	-10000	-4000	0	15000	10000	5000	1000
Utilities	-100	-60	-3	0	40	30	20	10

The distribution of cash flows of project A and Project B are as follows :

Project A

Cash Flow (₹)	-15000	-10000	15000	10000	5000
Probability	0.10	0.20	0.40	0.20	0.10

Project B

Cash Flow (₹)	-10000	-4000	15000	5000	10000
Probability	0.10	0.15	0.40	0.25	0.10

Which project should be selected and why ?

Answer

Evaluation of project utilizes of Project A and Project B

	Project A		
Cash flow (in ₹)	Probability	Utility	Utility value
-15,000	0.10	-100	-10
10,000	0.20	-60	-12
15,000	0.40	40	16
10,000	0.20	30	6

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5,000	0.10	20	<u>2</u>
			<u>2</u>

	Project B		
Cash flow (in ₹)	Probability	Utility	Utility value
-10,000	0.10	-60	-6
-4,000	0.15	-3	-0.45
15,000	0.40	40	16
5,000	0.25	20	5
10,000	0.10	30	<u>3</u>
			<u>17.55</u>

Project B should be selected as its expected utility is more

Question 35

X Ltd. had only one water pollution control machine in this type of block of asset with no book value under the provisions of the Income Tax Act, 1961 as it was subject to rate of depreciation of 100% in the very first year of installation.

Due to funds crunch, X Ltd. decided to sell the machine which can be sold in the market to anyone for ₹5,00,000 easily.

Understanding this from a reliable source, Y Ltd. came forward to buy the machine for ₹5,00,000 and lease it to X Ltd. for lease rental of ₹90,000 p.a. for 5 years. X Ltd. decided to invest the net sale proceed in a risk free deposit, fetching yearly interest of 8.75% to generate some cash flow. It also decided to relook the entire issue afresh after the said period of 5 years.

Another company, Z Ltd. also approached X Ltd. proposing to sell a similar machine for ₹4,00,000 to the latter and undertook to buy it back at the end of 5 years for ₹1,00,000 provided the maintenance were entrusted to Z Ltd. for yearly charge of ₹15,000. X Ltd. would utilise the net sale proceeds of the old machine to fund this machine also should it accept this offer.

The marginal rate of tax of X Ltd. is 34% and its weighted average cost of capital is 12%.

Which Alternative would you recommend ?

Discounting Factors @ 12%

Year	1	2	3	4	5
	0.893	0.797	0.712	0.636	0.567

Answer

First Option

	₹
Sale Proceeds	5,00,000
Tax @ 34%	<u>1,70,000</u>
Net Proceed	<u>3,30,000</u>
Interest @ 8.75% p.a.	= ₹ 28,875

NPV of this Option

	Year					
	0	1	2	3	4	5
Int. on Net Proceeds (₹)		28,875	28,875	28,875	28,875	28,875
Tax @ 34% (₹)		-9,818	-9,818	-9,818	-9,818	-9,818
Lease Rent (₹)		-90,000	-90,000	-90,000	-90,000	-90,000
Tax @34%(₹)		30,600	30,600	30,600	30,600	30,600
Terminal Cash Flow (₹)						3,30,000
Cash flow (₹)		-40,343	-40,343	-40,343	-40,343	2,89,657
PV Factor		0.893	0.797	0.712	0.636	0.567
PV of Cash Flows (₹)		-36,026	-32,153	-28,724	-25,658	1,64,236

NPV = ₹ 41,675

Second Option

	₹
Cost of New Machine	4,00,000
Net sale proceeds of old machine	<u>3,30,000</u>
Investment in Cash	<u>70,000</u>

NPV of this Option

	Year					
	0	1	2	3	4	5
Payment for new Machine (₹)	-70,000					
Tax saving ₹ 4,00,000 x 34%		1,36,000				
Maintenance (₹)		-15,000	-15,000	-15,000	-15,000	-15,000
Tax saving on above @ 34% (₹)		5,100	5,100	5,100	5,100	5,100

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Terminal Cash Flow (₹)						1,00,000
Tax on above @ 34% (₹)						-34,000
Cash Flow (₹)	-70,000	1,26,100	-9,900	-9,900	-9,900	56,100
PV Factor	1	0.893	0.797	0.712	0.636	0.567
PV of Cash Flows (₹)	-70,000	1,12,607	-7,890	-7,049	-6,296	31,809

NPV = ₹ 53,181

The second alternative is recommended.

Question 36

You own an unused Gold mine that will cost ₹10,00,000 to reopen. If you open the mine, you expect to be able to extract 1,000 ounces of Gold a year for each of three years. After that the deposit will be exhausted. The Gold price is currently ₹5,000 an ounce, and each year the price is equally likely to rise or fall by ₹500 from its level at the start of year. The extraction cost is ₹4,600 an ounce and the discount rate is 10 per cent.

Required:

- Should you open the mine now or delay one year in the hope of a rise in the Gold price?
- What difference would it make to your decision if you could costlessly (but irreversibly) shut down the mine at any stage? Show the value of abandonment option.

Answer

- (i) Assume we open the mine now at $t = 0$. Taking into account the distribution of possible future price of gold over the next three years, we have

$$\begin{aligned}
 \text{NPV} &= -\text{Rs. } 10,00,000 + \frac{1,000 \times [(0.5 \times 5,500 + 0.5 \times 4,500) - 4,600]}{1.10} \\
 &+ \frac{1,000 \times [(0.5)^2 (6,000 + 5,000 + 5,000 + 4,000) - 4,600]}{(1.10)^2} \\
 &+ \frac{1,000 \times [(0.5)^3 (6,500 + 5,500 + 5,500 + 4,500 + 4,500 + 5,500 + 4,500 + 3,500) - 4,600]}{(1.10)^3} \\
 &= - ₹ 5,260
 \end{aligned}$$

Because the NPV is negative, we should not open the mine at $t = 0$. It does not make sense to open the mine at any price less than or equal to ₹5,000 per ounce.

- (ii) Assume that we delay one year until $t = 1$, and open the mine if the price is ₹5,500. At that point:

$$= ₹ 10,00,000 + \sum_{t=1}^3 \frac{(1,000) \times (5,500 - 4,600)}{(1.10)^t} = ₹ 12,38,167$$

If the price at t_1 reaches ₹ 5,500, then expected price for all future periods is ₹ 5,500.

NPV at $t_0 = ₹ 12,38,167 / 1.10 = ₹ 11,25,606$

If the price rises to ₹ 5,500 at $t = 1$, we should open the mine at that time.

The expected NPV of this strategy is:

$$(0.50 \times ₹ 11,25,606) + (0.50 \times 0) = ₹ 5,62,803$$

As already stated mine should not be opened if the price is less than or equal to ₹ 5,000 per ounce.

If the price at t_1 reaches ₹ 4,500, then expected price for all future periods is ₹ 4,500. In that situation we should not open the mine.

- (b) Suppose we open the mine at $t = 0$, when the price is ₹ 5,000. At $t = 2$, there is a 0.25 probability that the price will be ₹ 4,000. Then since the price at $t = 3$ cannot rise above the extraction cost, the mine should be closed. If we open the mine at $t = 0$, when the price was ₹ 5,000 with the closing option the NPV will be:

$$\begin{aligned} \text{NPV} &= - \text{Rs. } 10,00,000 + \sum_{t=1}^2 \frac{(5,000 - 4,600) \times 1,000}{(1.10)^t} \\ &+ \frac{.125 \times [1,900 + 900 + 900 + 900 - 100 - 100] \times 1,000}{(1.10)^3} \\ &= ₹ 1,07,438 \end{aligned}$$

Therefore, the NPV with the abandonment option is ₹ 1,07,438.

The value of the abandonment option is:

$$0.25 \times 1,000 \times (600) / (1.10)^3 = ₹ 1,12,697$$

The NPV of strategy (2), that to open the mine at $t = 1$, when price rises to ₹ 5,500 per ounce, even without abandonment option, is higher than option 1. Therefore, the strategy (2) is preferable.

Under strategy 2, the mine should be closed if the price reaches ₹ 4,500 at $t = 3$, because the expected profit is $(₹ 4,500 - 4,600) \times 1,000 = - ₹ 1,00,000$.

The value of the abandonment option is:

$$0.125 \times (1,00,000) / (1.10)^4 = ₹ 8,538$$

Note: Students may also assume that the price of the gold remains at ₹ 5,000 to solve the question.

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Question 37

A & Co. is contemplating whether to replace an existing machine or to spend money on overhauling it. A & Co. 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 A & Co. is 15%.

Required:

When should the company replace the machine?

(Notes: Present value of an annuity of Re. 1 per period for 8 years at interest rate of 15% : 4.4873; present value of Re. 1 to be received after 8 years at interest rate of 15% : 0.3269).

Answer

A & Co.

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)	<u>44,873</u>
	1,34,873
Less: PV of salvage value at the end of 8 years (₹20,000 × 0.3269)	<u>6,538</u>
	<u>1,28,335</u>
Equivalent annual cost (EAC) (₹ 1,28,335/4.4873)	<u>28,600</u>

Equivalent Cost (EAC) of keeping the machine

Present value (p.v)	I Year (₹)	II Year (₹)	III Year (₹)	IV Year (₹)
Value Present	40,000	25,000	15,000	10,000
Add: PV of annual maintenance (Annual Maintenance/1.15)	<u>8,696</u>	<u>17,391</u>	<u>26,087</u>	<u>34,783</u>
Total	48,696	42,391	41,087	44,783
Less: PV of salvage value at the end of the year (p.v. /1.15)	<u>21,739</u>	<u>13,043</u>	<u>8,696</u>	<u>Nil</u>
	26,957	29,348	32,391	44,783
	<u>1.15</u>	<u>1.15</u>	<u>1.15</u>	<u>1.15</u>
Equivalent Annual Cost (EAC)	<u>31,000</u>	<u>33,750</u>	<u>37,250</u>	<u>51,500</u>

Advice: The company should replace the old machine immediately because the Equivalent Annual Cost (EAC) of the new machine at ₹ 28,600 is lower than the cost of using the existing machine in first year, second year, third year and fourth year.

Question 38

A company has an old machine having book value zero – which can be sold for ₹ 50,000. The company is thinking to choose one from following two alternatives:

- To incur additional cost of ₹ 10,00,000 to upgrade the old existing machine.
- To replace old machine with a new machine costing ₹ 20,00,000 plus installation cost ₹ 50,000.

Both above proposals envisage useful life to be five years with salvage value to be nil.

The expected after tax profits for the above three alternatives are as under :

Year	Old existing Machine (₹)	Upgraded Machine (₹)	New Machine (₹)
1	5,00,000	5,50,000	6,00,000
2	5,40,000	5,90,000	6,40,000
3	5,80,000	6,10,000	6,90,000
4	6,20,000	6,50,000	7,40,000
5	6,60,000	7,00,000	8,00,000

The tax rate is 40 per cent.

The company follows straight line method of depreciation. Assume cost of capital to be 15 per cent.

P.V.F. of 15%, 5 = 0.870, 0.756, 0.658, 0.572 and 0.497. You are required to advise the company as to which alternative is to be adopted.

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Answer

(A)	Cash Outflow	₹
(i)	In case machine is upgraded: Upgradation Cost	<u>10,00,000</u>
(ii)	In case new machine installed: Cost	20,00,000
	Add: Installation cost	<u>50,000</u>
	Total Cost	20,50,000
	Less: Disposal of old machine ₹ 50,000 – 40% tax	<u>30,000</u>
	Total Cash Outflow	<u>20,20,000</u>

Working Note:

- (i) Depreciation – in case machine is upgraded
₹ 10,00,000 ÷ 5 = ₹ 2,00,000
- (ii) Depreciation – in case new machine is installed
₹ 20,50,000 ÷ 5 = ₹ 4,10,000
- (iii) Old existing machine – Book Value is zero. So no depreciation.

(B) Cash Inflows after Taxes (CFAT)

Year	Old Existing Machine	Upgraded Machine			
	(i) EAT/CFAT ₹	(ii) EAT ₹	(iii) DEP ₹	(iv) CFAT ₹	= (iv)-(i) Incremental CFAT (₹)
1	5,00,000	5,50,000	2,00,000	7,50,000	2,50,000
2	5,40,000	5,90,000	2,00,000	7,90,000	2,50,000
3	5,80,000	6,10,000	2,00,000	8,10,000	2,30,000
4	6,20,000	6,50,000	2,00,000	8,50,000	2,30,000
5	6,60,000	7,00,000	2,00,000	9,00,000	2,40,000

Cash Inflow after Taxes (CFAT)

Year	New Machine			
	(vi) EAT ₹	(vii) DEP ₹	(viii) CFAT ₹	(ix) = (viii) – (i) Incremental CFAT (₹)
1	6,00,000	4,10,000	10,10,000	5,10,000
2	6,40,000	4,10,000	10,50,000	5,10,000
3	6,90,000	4,10,000	11,00,000	5,20,000
4	7,40,000	4,10,000	11,50,000	5,30,000
5	8,00,000	4,10,000	12,10,000	5,50,000

P.V. AT 15% - 5 Years – on Incremental CFAT

Year	Upgraded Machine			New Machine		
	Incremental CFAT ₹	PVF	Total P.V. ₹	Incremental CFAT	PVF	Total PV ₹
1	2,50,000	0.870	2,17,500	5,10,000	0.870	4,43,700
2	2,50,000	0.756	1,89,000	5,10,000	0.756	3,85,560
3	2,30,000	0.658	1,51,340	5,20,000	0.658	3,42,160
4	2,30,000	0.572	1,31,560	5,30,000	0.572	3,03,160
5.	2,40,000	0.497	<u>1,19,280</u>	5,50,000	0.497	<u>2,73,350</u>
Total P.V. of CFAT			8,08,680			17,47,930
Less: Cash Outflows			<u>10,00,000</u>			<u>20,20,000*</u>
N.P.V. =			<u>-1,91,320</u>			<u>-2,72,070</u>

*Acquisition Cost (including installation cost)

₹ 20,50,000

Less: Salvage Value of existing machine net of Tax

₹ 30,000

₹ 20,20,000

As the NPV in both the new (alternative) proposals is negative, the company should continue with the existing old Machine.

Question 39

- (a) Company X is forced to choose between two machines A and B. The two machines are designed differently, but have identical capacity and do exactly the same job. Machine A

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costs ₹ 1,50,000 and will last for 3 years. It costs ₹ 40,000 per year to run. Machine B is an 'economy' model costing only ₹ 1,00,000, but will last only for 2 years, and costs ₹ 60,000 per year to run. These are real cash flows. The costs are forecasted in rupees of constant purchasing power. Ignore tax. Opportunity cost of capital is 10 per cent. Which machine company X should buy?

- (b) Company Y is operating an elderly machine that is expected to produce a net cash inflow of ₹ 40,000 in the coming year and ₹ 40,000 next year. Current salvage value is ₹ 80,000 and next year's value is ₹ 70,000. The machine can be replaced now with a new machine, which costs ₹ 1,50,000, but is much more efficient and will provide a cash inflow of ₹ 80,000 a year for 3 years. Company Y wants to know whether it should replace the equipment now or wait a year with the clear understanding that the new machine is the best of the available alternatives and that it in turn be replaced at the optimal point. Ignore tax. Take opportunity cost of capital as 10 per cent. Advise with reasons.

Answer

(a) Statement showing the evaluation of two machines

Machines	A	B
Purchase cost (₹): (i)	1,50,000	1,00,000
Life of machines (years)	3	2
Running cost of machine per year (₹): (ii)	40,000	60,000
Cumulative present value factor for 1-3 years @ 10% (iii)	2.486	-
Cumulative present value factor for 1-2 years @ 10% (iv)	-	1.735
Present value of running cost of machines (₹): (v)	99,440	1,04,100
	[(ii) × (iii)]	[(ii) × (iv)]
Cash outflow of machines (₹): (vi) = (i) + (v)	2,49,440	2,04,100
Equivalent present value of annual cash outflow	1,00,338	1,17,637
	[(vi) ÷ (iii)]	[(vi) ÷ (iv)]

Decision: Company X should buy machine A since its equivalent cash outflow is less than machine B.

(b) Statement showing present value of cash inflow of new machine when it replaces elderly machine now

		₹
Cash inflow of a new machine per year		80,000
Cumulative present value for 1-3 years @ 10%		2.486

Present value of cash inflow for 3 years (₹ 80,000 × 2.486)		1,98,880
	₹	
Less: Cash outflow		
Purchase cost of new machine	1,50,000	
Less: Salvage value of old machine	<u>80,000</u>	<u>70,000</u>
N.P.V. of cash inflow for 3 years		1,28,880
Equivalent annual net present value of cash		
Inflow of new machine $\frac{₹ 1,28,880}{2.486}$		51,842

Statement showing present value of cash inflow of new machine when it replaces elderly machine next year

		₹
Cash inflow of a new machine per year		80,000
Cumulative present value for 1-3 years @ 10%		2.486
Present value of cash inflow for 3 years (₹ 80,000 × 2.486)		1,98,880
	₹	
Less: Cash outflow		
Purchase cost of new machine	1,50,000	
Less: Salvage value of old machine	<u>70,000</u>	<u>80,000</u>
N.P.V. of cash inflow for 3 years		1,18,880
Equivalent annual net present value of cash Inflow $\frac{₹ 1,18,880}{2.486}$		47,820

Present Value of NPV of Cash inflow $\frac{₹ 47,820}{1.10}$ 43,473

Advise: Since the equivalent annual cash inflow of new machine now and next year is more than cash inflow (₹ 40,000) of an elderly machine the company Y is advised to replace the elderly machine now.

Company Y need not wait for the next year to replace the elderly machine since the equivalent annual cash inflow now is more than the next year's cash inflow.

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Question 40

ABC Ltd. is considering a project in US, which will involve an initial investment of US \$ 1,10,00,000. The project will have 5 years of life. Current spot exchange rate is ₹48 per US \$. The risk free rate in US is 8% and the same in India is 12%. Cash inflow from the project is as follows:

Year	Cash inflow
1	US \$ 20,00,000
2	US \$ 25,00,000
3	US \$ 30,00,000
4	US \$ 40,00,000
5	US \$ 50,00,000

Calculate the NPV of the project using foreign currency approach. Required rate of return on this project is 14%.

Answer

$$(1 + 0.12) (1 + \text{Risk Premium}) = (1 + 0.14)$$
$$\text{Or, } 1 + \text{Risk Premium} = 1.14/1.12 = 1.0179$$

Therefore, Risk adjusted dollar rate is = $1.0179 \times 1.08 = 1.099 - 1 = 0.099$

Calculation of NPV

Year	Cash flow (Million) US\$	PV Factor at 9.9%	P.V.
1	2.00	0.910	1.820
2	2.50	0.828	2.070
3	3.00	0.753	2.259
4	4.00	0.686	2.744
5	5.00	0.624	<u>3.120</u>
			12.013
		Less: Investment	<u>11.000</u>
		NPV	<u>1.013</u>

Therefore, Rupee NPV of the project is = ₹ (48 x 1.013) Million
= ₹48.624 Million

Question 41

A USA based company is planning to set up a software development unit in India. Software developed at the Indian unit will be bought back by the US parent at a transfer price of US \$10 millions. The unit will remain in existence in India for one year; the software is expected to get developed within this time frame.

The US based company will be subject to corporate tax of 30 per cent and a withholding tax of 10 per cent in India and will not be eligible for tax credit in the US. The software developed will be sold in the US market for US \$ 12.0 millions. Other estimates are as follows:

Rent for fully furnished unit with necessary hardware in India	₹15,00,000
Man power cost (80 software professional will be working for 10 hours each day)	₹400 per man hour
Administrative and other costs	₹12,00,000

Advise the US Company on the financial viability of the project. The rupee-dollar rate is ₹48/\$.

Answer**Proforma profit and loss account of the Indian software development unit**

	₹	₹
Revenue		48,00,00,000
Less: Costs:		
Rent	15,00,000	
Manpower (₹400 x 80 x 10 x 365)	11,68,00,000	
Administrative and other costs	12,00,000	11,95,00,000
Earnings before tax		36,05,00,000
Less: Tax		10,81,50,000
Earnings after tax		25,23,50,000
Less: Withholding tax(TDS)		2,52,35,000
Repatriation amount (in rupees)		22,71,15,000
Repatriation amount (in dollars)		\$4.7 million

Note: Students may assume the year of 360 days instead of 365 days as has been done in the answer provided above. In such a case where a year is assumed to be of 360 days,

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manpower cost is Rs 11,52,00,000 and repatriated amount Rs 22,87,15,000.

Advise: The cost of development software in India for the US based company is \$5.268 million. As the USA based Company is expected to sell the software in the US at \$12.0 million, it is advised to develop the software in India.

EXERCISES

Question 1

A company is considering two mutually exclusive projects X and Y. Project X costs ₹ 30,000 and Project Y ₹ 36,000. You have been given below the net present value, probability distribution for each project:

Project X		Project Y	
NPV Estimate	Probability	NPV Estimate	Probability
₹		₹	
3,000	0.1	3,000	0.2
6,000	0.4	6,000	0.3
12,000	0.4	12,000	0.3
15,000	0.1	15,000	0.2

- Compute the expected net present value of Projects X and Y.
- Compute the risk attached to each project i.e., Standard Deviation of each probability distribution.
- Which project do you consider more risky and why?
- Compute the profitability index of each project.

Answer

	Project X	Project Y
The expected net present value	₹ 9,000	₹ 9,000
Standard Deviation	₹ 3,795	₹ 4,450
Coefficient of variation	0.42	0.49
Profitability index	1.30	1.25

Question 2

Determine the risk adjusted net present value of the following projects:

	A	B	C
Net cash outlays (₹)	1,00,000	1,20,000	2,10,000
Project life	5 years	5 years	5 years
Annual cash inflow (₹)	30,000	42,000	70,000
Coefficient of variation	0.4	0.8	1.2

The company selects the risk-adjusted rate of discount on the basis of the co-efficient of variation:

Coefficient of variation	Risk adjusted rate of discount	Present value factor 1 to 5 years at risk adjusted rate of discount
0.0	10%	3.791
0.4	12%	3.605
0.8	14%	3.433
1.2	16%	3.274
1.6	18%	3.127
2.0	22%	2.864
More than 2.0	25%	2.689

(Answer: NPV of Project A- 8,150, Project B- 24,186 and Project C- 19,180)

Question 3

C developed original specification of a product and founded C Manufacturing Ltd. In 2007 the firm manufactured 980 Nos. at an average price of ₹ 900 each. In 2008 due to continuous price rise of the inputs, he raised his prices at an average of 12%, since he knew he could sell is plant's full capacity of 980 Nos. per year. In spite of price rise for the product, which sold for over ₹ 1,000 for the first time, C was surprised to learn in late 2008 (as may be seen from the financial statements) that C Manufacturing Ltd. show a decline in earnings and still worse, decline in cash flow.

His accountant has brought the following:

- (i) We are following FIFO system for the purpose of issues.
- (ii) Costs are going up faster than 12% and they will go up further in 2009.
- (iii) We are not setting aside enough to replace the machinery; we need to set aside ₹ 1,65,000, not ₹ 1,50,000 so as to be able to buy new machinery.
- (iv) It is still not late to switch to LIFO for 2008. This will reduce closing inventory to ₹ 3,30,000 and raise cost of goods sold.

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	C Manufacturing Ltd.		Income Statement (₹ 000)	
		2008		2007
Sales		1,008		900
Cost of goods sold				
Opening inventory	320		250	
Raw material	500		400	
Labour	200		174	
Depreciation	150		150	
End inventory	(-)390		(-)320	
		780		654
Gross margin		228		246
Administration expenses		<u>100</u>		<u>92</u>
EBIT		128		154
Interest		<u>50</u>		<u>50</u>
		78		104
Income-tax		<u>39</u>		<u>52</u>
Profit after tax		39		52
Add: Non-cash expenses		150		150
Inventory change		<u>(-)70</u>		<u>(-)70</u>
Cash flow		<u>119</u>		<u>132</u>

Required:

- What is the weighted average inflation factor for the firm using LIFO?
- If the firm desires a 15 per cent profit margin on sales, how much should the firm charge for the product per unit?

(Answer (i) Weighted average inflation factor for the firm in 2008 = $\frac{955}{746}$

= 1.28 i.e. 28% over 2007

- Total sales will be ₹ 11,52,000 approximately and alternatively, Total sales will be ₹ 11,23,570)

Question 4

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 ₹ 50 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 ₹ 30 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 ₹ 200 lakhs to be financed by a loan repayable in 4 equal instalments commencing from the end of year 1. The interest rate is 16% per annum. At the end of the 4th year, the machine can be sold for ₹ 20 lakhs and the cost of dismantling and removal will be ₹ 15 lakhs.

Sales and direct costs of the product emerging from waste processing for 4 years are estimated as under:

			₹ in lakhs	
Year	1	2	3	4
Sales	322	322	418	418
Material consumption	30	40	85	85
Wages	75	75	85	100
Other expenses	40	45	54	70
Factory overheads	55	60	110	145
Depreciation (as per income-tax rules)	50	38	28	21

Initial stock of materials required before commencement of the processing operations is ₹ 20 lakhs at the start of year 1. The stock levels of materials to be maintained at the end of year 1, 2 and 3 will be ₹ 55 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 ₹ 10 lakhs per annum. Labour costs include wages of 40 workers, whose transfer to this process will reduce idle time payments of ₹ 15 lakhs in year 1 and ₹ 10 lakhs in year 2. Factory overheads include apportionment of general factory overheads except to the extent of insurance charges of ₹ 30 lakhs per annum payable on this venture. The company's tax rate is 50%.

Present value factors for four years are as under:

Year	1	2	3	4
Present value factors	0.870	0.756	0.658	0.572

Advise the management on the desirability of installing the machine for processing the waste. All calculations should form part of the answer.

(Answer: Net present Value = ₹ 123.658 – ₹ 50 = 73.658 lakhs.)

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Question 5

ABC Company Ltd. has been producing a chemical product by using machine Z for the last two years. Now the management of the company is thinking to replace this machine either by X or by Y machine. The following details are furnished to you:

	Z	X	Y
Books value (₹)	1,00,000	-	-
Resale value now (₹)	1,10,000	-	-
Purchase price (₹)	-	1,80,000	2,00,000
Annual fixed costs (including depreciation) (₹)	92,000	1,08,000	1,32,000
Variable running costs (including labour) per unit (₹)	3	1.50	2.50
Production per hour (unit)	8	8	12
You are also provided with the following details:			
Selling price per unit			(₹) 20
Cost of materials per unit			(₹) 10
Annual operating hours			2,000
Working life of each of the three machines (as from now)			5 years
Salvage value of machines Z ₹ 10,000, X ₹ 15,000, Y ₹ 18,000			

The company charges depreciation using straight line method. It is anticipated that an additional cost of ₹ 8,000 per annum would be incurred on special advertising to sell the extra output of machine. Assume tax rate of 50% and cost of capital 10%. The present value of Re. 1 to be received at the end of the year at 10% is as under:

Year	1	2	3	4	5
Present value	.909	.826	.751	.683	0.621

Required: Using NPV method, you are required to analyse the feasibility of the proposal and make recommendations.

Answer

Computation of Net Present Value

Machine	Z	X	Y
Net Present Value	9,910	7,445	24,934.00
Profitability Index	1.09	1.041	1.12

Question 6

The Globe Manufacturing Company Ltd. is considering an investment in one of the two mutually exclusive proposals – Projects X and Y, which require cash outlays of ₹ 3,40,000 and ₹ 3,30,000 respectively. The certainty-equivalent (C.E.) approach is used in incorporating risk in capital budgeting decisions. The current yield on government bond is 8% and this be used as the riskless rate. The expected net cash flows and their certainty-equivalents are as follows:

Year-end	<u>Project X</u>		<u>Project Y</u>	
	Cash flow	C.E.	Cash flow	C.E.
	₹		₹	
1	1,80,000	.8	1,80,000	.9
2	2,00,000	.7	1,80,000	.8
3	2,00,000	.5	2,00,000	.7

Present value factors of Re. 1 discounted at 8% at the end of year 1, 2 and 3 are .926, .857 and .794 respectively.

Required:

- Which project should be accepted?
- If risk adjusted discount rate method is used, which project would be analysed with a higher rate?

Answer

- Net present value Project X (7,276)

Net present value Project Y 54,580
- Since the certainty-equivalent (C.E.) Co-efficient of project X is lower than project Y, the project X is riskier than project Y. Therefore, if risk adjusted discount rate method is used the project X would be analysed with a higher rate.

Question 7

A firm has an investment proposal, requiring an outlay of ₹ 40,000. The investment proposal is expected to have 2 years' economic life with no salvage value. In year 1, there is a 0.4 probability that cash inflow after tax will be ₹ 25,000 and 0.6 probability that cash inflow after tax will be ₹ 30,000. The probabilities assigned to cash inflows after tax for the year II are as follows:

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The Cash inflow year I	₹ 25,000		₹ 30,000	
The Cash inflow year II		Probability		Probability
	₹ 12,000	0.2	₹ 20,000	0.4
	₹ 16,000	0.3	₹ 25,000	0.5
	₹ 22,000	0.5	₹ 30,000	0.1

The firm uses a 10% discount rate for this type of investment.

Required:

- Construct a decision tree for the proposed investment project.
- What net present value will the project yield if worst outcome is realized? What is the probability of occurrence of this NPV?
- What will be the best and the probability of that occurrence?
- Will the project be accepted?

(10% Discount factor	1 year	0.909
	2 year	0.826)

Answer:

- Joint Probability**

Path	Joint Probability
1	0.08
2	0.12
3	0.20
4	0.24
5	0.30
6	0.06

- Worst outcome-NPV- ₹ 7,363 (negative) and probability of this NPV is 8%.
- Best outcome-NPV- ₹ 12,050 (positive) and probability of this NPV is 6%.
- Yes, the project will be accepted since the Expected Net present value ' probability sum total is positive.

Question 8

Neale Tech Plc proposes to launch a new product. The company appointed Kachy Consultants to conduct market study. The consultants suggested that the price of product can be set £36 or £38 or £40 per unit. The company intends to hire a machinery to manufacture

the product at £400 000 per annum. However, if annual production exceeds 60 000 units, additional cost of £160 000 per annum will be incurred for hire of machinery. The following data is related to the estimated sale and possible selling prices.

Table I

Selling Price	£36		£38		£40	
	Units	Prob.	Units	Prob.	Units	Prob.
Pessimistic	70 000	0.3	60 000	0.1	30 000	0.4
Most likely	80 000	0.5	70 000	0.7	60 000	0.5
Optimistic	90 000	0.2	90 000	0.2	70 000	0.1

Table – II

Variable Cost	Prob.
£10	0.6
£12	0.4
	1.00

The company has committed publicity expenditure of £80 000 per annum. You are required to analyse and advise which selling price shall lead to maximization of profit.

(Answer: There are 16 scenarios possible and the expected value of profit is maximum at the selling price of £38. So the firm should fix up the price at £38.)

Question 9

Small Oil is wondering whether to drill for oil in Chemsfield Basin. The prospectuses are as follows:

Depth of well in feet	Total cost (Million €)	Probability of		PV of Oil (if found) (Million €)
		Finding oil	Not Finding oil	
2000	4	0.5	0.5	10
4000	5	0.2	0.8	9
6000	6	0.25	0.75	8

Draw a decision tree showing the successive drilling decisions to be made by Small Oil. How deep should it be prepared to drill?

(Answer: Using rolling back technique, we shall take the decision at decision point D₃ first and then it to arrive decision at a decision point D₂ and then use it to arrive decision at a point D₁. At D₃ small oil should drill upto 6000 feet, at D₂ small oil should drill upto 4000 feet and at D₁ Small oil should drill upto 2000 feet.)