Unit 7

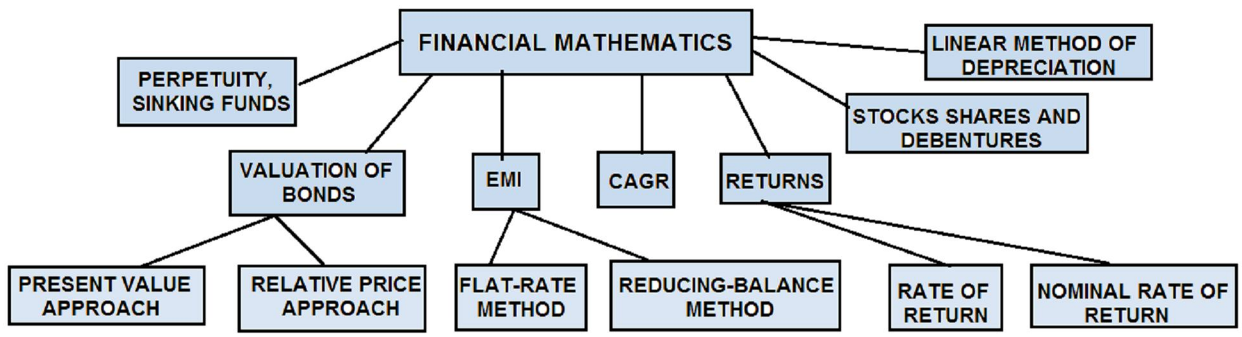
Financial Mathematics

7.0 LEARNING OUTCOMES

At the end of this unit, the student will be able to:

- Explain the concept of perpetuity and sinking fund.
- Calculate perpetuity.
- Differentiate between sinking fund and savings account.
- Define the concept of valuation of bond and related terms.
- Calculate value of bond using present value approach.
- Explain the concept of EMI.
- Calculate EMI using various methods.
- Explain the concept of rate of return and nominal rate of return.
- Calculate rate of return and nominal rate of return.
- Understand the concept of Compound Annual Growth Rate.
- Differentiate between Compound Annual Growth Rate and Annual Growth Rate.
- Calculate Compound Annual Growth Rate.
- Explain the concept of Stocks, shares and Debentures.
- Enlist features related to equity shares and debentures.
- Interpret case studies related to shares and debentures (Simple Case Studies only).
- Define the concept of linear method of depreciation.
- Interpret cost, residual value and useful life of an asset from the given information.
- Calculate depreciation using linear method of depreciation.

CONCEPT MAP



Introduction

Financial mathematics is of great importance in our day-to-day life. The entire operation in banking, insurance, property dealing etc. are based on the concept of money belonging to one individual that may be used by others in return for periodic payments. Interest plays an important role in almost all the financial activities. Many people have set up their own finance companies and are earning a lot.

In this chapter, we shall discuss some of the basic topics of finance.

7.1.1 Perpetuity:

Perpetuity: A perpetuity is an annuity where payments continue forever.

Amount of a Perpetuity: Amount of a perpetuity is undefined since it increases beyond all bounds as time goes on.

Present value of Perpetuity: We consider two types of perpetuity which are as follows:

(i) The present value of a perpetuity of ₹ R payable at the end of each period, the first payment due one period hence is the sum of money which is invested now at the rate i per period will yield ₹ R at the end of each period forever. It is given by

$R\ (I + i)^{-1} + R\ (I + i)^{-2} +$ ————-

It is an infinite geometric series with first term $R\ (1+i)^{-1}$ and whose common ratio is $(1+i)^{-1}$

Its sum is given by

$$\frac{R(1+i)^{-1}}{1-(1+i)^{-1}}$$

$$= \frac{R}{i}$$

Present value of a perpetuity of ₹ R payable at the end of each period, the first being due one period hence is

$$P = \frac{R}{i}$$

where R = size of each payment

i = rate per period

(ii) Perpetuity of ₹ R payable at the beginning of each period, the first payment due on Present value. This annuity can be considered as an initial payment of ₹ R followed by a perpetuity of ₹ R of above type.

Thus, the present value is given by $R + \frac{R}{i}$

where, R = size of each payment

i = rate per period

Example 1

Find the present value of a sequence of payments of ₹ 60 made at the end of each 6 months and continuing forever, if money is worth 4% compounded semi-annually.

Solution: This is a perpetuity of type (i), since payments are made at the end of each period. given that

$R = 60$ and $i = \frac{0.04}{2} = 0.02$

Then present value of a perpetuity

$P = \frac{R}{i} = \frac{60}{0.02} =$ ₹ 3000

Example 2

At 6% converted quarterly, find the present value of a perpetuity of ₹ 600 payable at the end of each quarter.

Solution: Given that

$R = 600,\ i = \frac{0.06}{4} = 0.015$

Then the present value of a perpetuity

$P = \frac{R}{i} = \frac{600}{0.015} =$ ₹ 40,000

Example 3:

At what rate converted semi-annually will the present value of a perpetuity of ₹ 450 payable at the end of each 6 months be ₹ 20,000?

Solution: let r be the interest rate converted semi-annually. Then i, the interest rate per period is $\frac{r}{2}$

Since $P = \frac{R}{i}$

where $P = 20{,}000$ and $R = 450$

we have $i = \frac{R}{P} = \frac{450}{20{,}000} = 0.0225$

$\frac{r}{2} = 0.0225$

$r = 0.045$ or 4.5 %

Example 4:

How much money is needed to endure a series of lectures costing ₹ 2500 at the beginning of each year indefinitely, if money is worth 3% compounded annually?

Solution: We have R= 2500, i = 0.03 Money needed to endure a series of lectures costing ₹ 2500 at the beginning of each year means the present value of a perpetuity of ₹ 2500 payable at the beginning of each year

$$P = R + \frac{R}{i} = 2500 + \frac{2500}{0.03}$$

$$= ₹\ 85833.33$$

Example 5:

The present value of a perpetual income of ₹ x at the end of each six months is ₹ 40000. Find the value of x if money is worth 6% compounded semi-annually.

Solution: We have P = 40,000

$$i = \frac{0.06}{2} = 0.03$$

We know that

$$P = \frac{R}{i}$$

$$40{,}000 = \frac{x}{0.03}$$

X = 40,000 x 0.03 = ₹ 1200

7.1.2 Sinking Fund:

A sinking fund is a fund established by a company or business entity by setting aside revenue over a period of time to fund a future capital expense, or repayment of a long-term debt. It is a fund that is accumulated for the purpose of paying off a financial obligation at some future designated date.

The periodic payments of ₹ R made at the end of each period required to accumulate a sum of ₹ A over n periods with interest charged at the rate i per period is

$$R = \frac{A}{S_{\overline{n|}i}}$$

Where $$S_{\overline{n|}i} = \frac{(1+i)^n - 1}{i}$$

R = Size of each instalment or payment

i = rate per period

n = number of instalments

A = lumpsum amount to be accumulated

Remark: The problems relating to Sinking Fund are solved by using known formulas for the amount of an ordinary annuity or annuity due as the case may be depending on whether the payments are set aside at the end or beginning of each payment interval.

Difference between Sinking Fund and Savings Account

Sinking fund and savings account, both, involve setting aside an amount of money for the future. The main difference is that the sinking fund is set up for a particular purpose and is to be used at a particular time, while the savings account is set up for any purpose that it may serve.

Example 6:

A company establishes sinking fund to provide for the payment of ₹ 1,00,000 debt. maturing in 4 years. Contributions to the fund are to be made at the end of every year. Find the amount of each annual deposit if interest is 18% per annum.

Solution: let each annual deposit to the sinking fund be ₹ R. Then R is given by

$$A = RS_{\overline{n|}\,i} = R\left[\frac{(1+i)^n - 1}{i}\right]$$

=> $1,00,000 = R\left[\frac{(1+0.18)^4-1}{0.18}\right]$

$= R\left[\frac{(1.18)^4-1}{0.18}\right]$

$= R\left[\frac{1.9388-1}{0.18}\right]$

$= R\left[\frac{.9388}{0.18}\right] = R\ (5.2156)$

=> $R = \frac{1,00,000}{5.2156}$ = ₹ 19,173.25

Example 7

In 10 years, a machine costing ₹ 40,000 will have a salvage value of ₹ 4,000. A New Machine at that time is expected to sell for ₹ 52,000. In order to provide funds for the difference between the replacement cost and the salvage cost, a sinking fund is set up into which equal payments are placed at the end of each year. If the fund earns interest at the rate 7% compounded annually, how much should each payment be?

Solution: Amount needed after 10 years

= Replacement Cost - Salvage Cost

= 52,000 – 4,000 = 48,000

The payments into sinking fund consisting of 10 annual payments at the rate 7% per year is given by

$$A = RS_{\overline{n|}\,i} = R\left[\frac{(1+i)^n - 1}{i}\right]$$

=> $48,000 = R\left[\frac{(1+0.07)^{10}-1}{0.07}\right]$

= $R\left[\frac{(1.07)^{10}-1}{0.07}\right]$

=> $R = \frac{48000}{13.8164480}$ = ₹ 3474.12

Example 8:

Mr X plans to save amount for higher studies of his son, required after 10 years. He expects the cost of these studies to be ₹ 1,00,000. How much should he save at the beginning of each year to accumulate this amount at the end of 10 years, if the interest rate is 12% compounded annually?

Solution: Let the size of each annual payment be ₹ R. These payments represent annuity due consisting 10 annual payments at the rate 0.12 per annum. Thus, using the following formula for the amount of annuity due:

$$A = R\,[S_{\overline{n+1}|\,i} - 1]$$

Where A = 1,00,000, n = 10 and i = 0.12

ð $$1,00,000 = R\,[S]_{\overline{11}|0.12} - 1]$$

$$= R\left[\frac{(1.12)^{11} - 1}{0.12}\right]$$

$$= R\,(19.65458)$$

=> $$R = \frac{1,00,000}{19.65458}$$

$$= ₹\ 5087.87$$

EXERCISE 7.1

1. Find the present value of a sequence of payments of ₹ 80 made at the end of each 6 months and continuing forever, if money is worth 4% compounded semi-annually.
2. Find the present value of an annuity of ₹ 1800 made at the end of each quarter and continuing forever, if money is worth 5% compounded quarterly.
3. If the cash equivalent of a perpetuity of ₹ 300 payable at the end of each quarter is ₹ 24,000. Find the rate of interest compounded quarterly?
4. Find the present value of a perpetuity of ₹ 780 payable at the beginning of each year, if money is worth 6% effective.
5. The present value of a perpetual income of ₹ x at the end of each 6 months is ₹ 36000.
   Find the value of x if money is worth 6% compounded semi-annually.
6. If you need ₹ 20,000 for your daughter's education, how much must you set aside each quarter for 10 years to accumulate this amount at the rate of 6% compounded quarterly?
7. To save for child's education, a sinking fund is created to have ₹ 1,00,000 at the end of 25 years. How much money should be retained out of the profit each year for the sinking fund, if the investment can earn interest at the rate 4% per annum.
8. A machine costs ₹ 1,00,000 and its effective life is estimated to be 12 years. A sinking fund is created for replacing the machine by a new model at the end of its lifetime when its scrap realises a sum of ₹ 5,000 only. Find what amount should be set aside at the end of each year, out of the profits, for the sinking fund if it accumulates at 5% effective.
9. Suppose a machine costing ₹ 50,000 is to be replaced at the end of 10 years, at that time it will have a salvage value of ₹ 5,000. In order to provide money at that time for a machine costing the same amount, a sinking fund is set up. The amount in the fund at that time is to be the difference between the replacement cost and salvage value. If equal payments are placed in the fund at the end of each quarter and the fund earns 8% compounded quarterly. What should each payment be?

VALUATION OF BONDS

Bond: It is a written contract between a borrower and a lender (bond holder). Through this contract, the borrower promises to pay a specified sum at a specific future date and to pay interest payments at a specific rate at equal intervals of time until the bond is redeemed (repaid).

A bond is characterized by following terms:

Face Value: The face value (also known as par value) of a bond is the price at which the bond is sold to buyers (investors) at the time of issue. It is also the price at which the bond is redeemed at maturity. It is also known as the par value of the bond.

Redemption Price: It is the amount the bond issuer pays at maturity. It is usually equal to the face value in case the bond is redeemed at **par**.

Discount: Where the market price of bond is less than its face value (par value), the bond is selling at a **discount.**

Premium: if the market price of bond is greater than its face value, the bond is selling at a **premium.**

Bond valuation: is the determination of the fair price of a bond. As with any security or capital investment, the theoretical fair value of a bond is the present value of the stream of cash flows it is expected to generate. Hence, the value of a bond is obtained by discounting the bond's expected cash flows to the present using an appropriate discount rate.

Nominal rate of interest: It is the rate at which a bond yields interest. It's also known as coupon rate.

Coupon Rate: A bond's coupon rate denotes the annual interest rate paid by the bond issuer to the bond holder. It is simply the coupon payment C as a percentage of the face value F. Coupon yield is also called nominal yield.

$$\text{Coupon rate} = \frac{C}{F}$$

Current Yield: The current yield is simply the coupon payment C as a percentage of the (current) bond price P_o.

$$\text{Current yield} = \frac{C}{P_0}$$

Yield to Maturity (YTM): The yield to maturity (YTM) is the discount rate which returns the market price of a bond without embedded optionality; it is identical to required return. YTM is thus the internal rate of return of an investment in the bond made at the observed price. Since YTM can be used to price a bond, bond prices are often quoted in terms of YTM.

To achieve a return equal to YTM, the bond owner must:

- Buy the bond at a price P_o
- Hold the bond until maturity
- Redeem the bond at par

Relationship between Bond, YTM and Coupon yield

The concept of current yield is closely related to the other bond concepts, including yield to maturity and coupon yield. The relationship between yield to maturity and the coupon rate is as follows:

- When a bond sells at a discount, YTM > current yield > coupon yield.
- When a bond sells at a premium, coupon yield > current yield > YTM
- When a bond sells at par, YTM = current yield = coupon yield

Present Value Approach (or bonds with a maturity period)

- When a bond or debenture has a maturity date, the value of a bond will be calculated by considering the annual interest payments plus its terminal value using the present value concept, the discounted value of these flows will be calculated.
- By comparing the present value of a bond with its current market value, it can be determined whether the bond is overvalued or undervalued.
- In the present value approach, we first calculate the present value of each expected cash flow and then we add all the individual present values to obtain the value or fair value of purchase price of a bond.

Let there be a bond where

Value of bond or Market price of bond or, purchase price of bond = V

Face Value = F

Redemption price or Maturity value = C

Number of cash flows or number of periodic payments = n

i_d be the rate of interest per period

Let periodic dividend payment R (periodic – interest) is given by,

$R = C \times i_d$

Let Yield rate or interest rate per period = i

Coupon payment or periodic interest (dividend) payment = R

Present value of annuity of periodic dividend payments of R for n periods is given by

$$P_1 = R\left[\frac{1-(1+i)^{-n}}{i}\right]$$

The present value of redemption price of the bond is given by:

$P_2 = C\ (1+i)^{-n}$

Let V be the purchase price of the bond, then

$V = P_1 + P_2$

$$V = R\left[\frac{1-(1+i)^{-n}}{i}\right] + C\ (1+i)^{-n}$$

In other words

Bond Value = Present value of first periodic payment + Present value of second periodic payment+ . . . + Present value of nth periodic payment + Present value of Redemption price/Maturity value

$$= \frac{R}{1+i} + \frac{R}{(1+i)^2} + \ldots + \frac{R}{(1+i)^n} + \frac{C}{(1+i)^n}$$

$$= \frac{R}{1+i}\,\frac{\left\{1-\left(\frac{1}{1+i}\right)^n\right\}}{\left(1-\frac{1}{1+i}\right)} + \frac{C}{(1+i)^n}$$

Bond Value (V) = R $\left[\frac{1-(1+i)^{-n}}{i}\right]$ + C $(1+i)^{-n}$

Note: If a bond is redeemed at par, then C=F

V = R $\left[\frac{1-(1+i)^{-n}}{i}\right]$ + F $(1+i)^{-n}$

Example 9

Find the purchase price of a ₹ 600, 8% bond, dividends payable semi-annually redeemable at par in 5 years, if the yield rate is to be 8% compounded semi-annually.

Solution: Face value of the bond C = ₹ 600

Nominal rate of interest i = 8% or 0.08

As dividends are paid semi-annually

Therefore, Rate of interest per period $i_d = \frac{0.08}{2} = 0.04$

Therefore, periodic dividend payment R = C x i_d = 600 x 0.04 = 24

So, semi-annual dividend R is ₹ 24

Yield rate is 8% = 0.08, compounded semi annually

Therefore $i = \frac{0.08}{2} = 0.04$

No. of years n = 5

Therefore, no. of dividend periods (n) = 5 x 2 = 10

Purchase price (V) of the bond is given by

V = R $\left[\frac{1-(1+i)^{-n}}{i}\right]$ + C $(1+i)^{-n}$

= 24 $\left[\frac{1-(1+0.04)^{-10}}{0.04}\right]$ + 600 $(1+0.04)^{-10}$

= 24 $\left[\frac{1-(1.04)^{-10}}{0.04}\right]$ + 600 $(1.04)^{-10}$

= 24 $\left[\frac{1-0.6755}{0.04}\right]$ + 600 (0.6755)

= 194.7 + 405.3 = 600

Therefore, purchase price of bond is ₹ 600.

Example 10

A ₹ 2,000, 8% bond is redeemable at the end of 10 years at ₹ 105. Find the purchase price to yield 10% effective rate.

Solution: Face value of the bond C = ₹ 2,000

As the bond is redeemable at ₹ 105, so redemption price of the bond is 105 % of its face value.

Therefore, redemption value C= 1.05 x 2,000 = ₹ 2,100

Nominal rate i_d = 8 % or 0.08

So R = C x i_d = 2,000 x 0.08 = ₹ 160

No. of periods before redemption n = 10

Annual yield rate i = 10 % or 0.1

Therefore, purchase price V is given by,

$$V = R\left[\frac{1-(1+i)^{-n}}{i}\right] + C\ (1+i)^{-n}$$

$$= 160\left[\frac{1-(1+0.1)^{-10}}{0.1}\right] + 2100\ (1+0.1)^{-10}$$

$$= 160\left[\frac{1-(1.1)^{-10}}{0.1}\right] + 2100\ (1.01)^{-10}$$

$$= 160\left[\frac{1-0.3855}{0.1}\right] + 2100\ (0.3855)$$

= 160 (6.14) + 2100 (0.3855)

= 982.4 + 809.6

= 1792

Therefore, the present value of the bond is ₹ 1,792.

Example 11

Consider a bond with a coupon rate of 10% charged annually. The par value is ₹ 2,000 and the bond has 5 years to maturity. The yield to maturity is 11 %. What is the value of the bond₹

Solution: Face value C = ₹ 2,000

Coupon rate i_d = 10 % annually or 0.1

Therefore R = C x i_d = 2,000 x 0.1 = ₹ 200

No. of periods before redemption (n) = 5

Yield rate i= 11 % or 0.11

Therefore

$$V = R\left[\frac{1-(1+i)^{-n}}{i}\right] + C\ (1+i)^{-n}$$

$$= 200\left[\frac{1-(1+0.11)^{-5}}{0.11}\right] + 2000\ (1+0.11)^{-5}$$

$$= 200\left[\frac{1-(1.11)^{-5}}{0.11}\right] + 2000(1.11)^{-5}$$

$$= 200\left[\frac{1-0.593451}{0.11}\right] + 2000\ (0.593451)$$

= 200 (3.6959) + 1186.902

= 739.18 + 1186.902

= 1926.08

Therefore, the value of the bond is ₹ 1,927.

Relative price approach: Under this approach, the bond will be priced relative to a benchmark usually a government security. Here, the yield to maturity on the bond is determined based on the bond's credit rating relative to a government security with similar maturity/duration. The better the quality of the bond, the smaller the spread between its required return and the YTM of the benchmark.

Exercise 7.2

1. What should be the price of the bond to yield an effective interest rate of 8% if it has a face value of ₹ 1,000 and maturity period of 15 years? The nominal interest rate is 10%.
2. Suppose a bond has a face value of ₹ 1,000, redeemable at the end of 12 years at 15% premium and paying annual interest at 8%. If the yield rate is to be 10% p.a. effective then what will be the purchase price of the bond?
3. An investor is considering purchasing a 5 year bond of ₹ 1,00,000 at par value and an annual fixed coupon rate of 12% while coupon payments are made semi-annually. The minimum yield that the investor would accept is 6.75%. Find the fair value of the bond.
4. Suppose that a bond has a face value of ₹ 1,000 and will mature in 10 years. The annual coupon rate is 5%, the bond makes semi-annual coupon payments. With a price of ₹ 950, what is the bond's YTM?
5. A bond with a face value of ₹ 1,000 matures in 10 years. The nominal rate of interest on bond is 11% p.a. paid annually. What should be the price of the bond so as to yield effective rate of return equal to 8%?
6. What is the value of the bond, considering a bond has a coupon rate of 10% charged annually, par value being ₹ 1,000 and the bond has 5 years to maturity. The yield to maturity is 11%.

7.3 Calculation of EMI or Amortization of Loans

People spend the money that they earn on housing, gadgets etc and on some extra expenditures to be met with. For example, one may want to buy a car or a house, one may want to set up his or her business or may go for a foreign trip and so on. Some people plan and manage to put aside some money for such expenditures but most people have to borrow money/take loan for such contingencies. This loan is paid by the borrower to the lender within a defined length of time. However, when we talk about loans and how to pay it back, the most important term we need to understand is EMI. Before knowing EMI, we need to understand basic terms related to it.

Principal: It is the initial amount of money borrowed (or invested).

Interest: It is the price paid by a borrower for the use of lender's money. It is the difference between initial amount borrowed and end payment made to the lender.

Rate of Interest: It is the percentage of the sum borrowed which is charged for a defined length of time for using the principal generally on a yearly basis.

Term of Loan: It is the defined length of time it will take for a loan to be completely paid off when the borrower is making regular payments.

Meaning of EMI

EMI stands for equated monthly instalment. It is a monthly payment that we make towards a loan we opted for at a fixed date of every month.

A loan is said to be amortized if it can be discharged by a sequence of equal payments (EMI) made over equal periods of time. Each payment can be considered as consisting of two parts:

(i) Interest on the outstanding loan, and

(ii) Repayment of part of the loan

Thus, a loan is amortized when part of each periodic payment is used to pay interest and the remaining part is used to reduce the principal.

7.3.1 Methods of calculation of EMI or Instalment

EMI or Instalment can be calculated by two methods:

1. Flat Rate Method
2. Reducing-balance method or Amortization of Loan

Flat Rate Method: - In the flat-rate method, each interest charge is calculated based on the original loan amount, even though the loan balance outstanding is gradually being paid down. The EMI amount is calculated by adding the total principal of the loan and the total interest on the principal together, then dividing the sum by the number of EMI payments, which is the number of months during the loan term.

Let P, I and n be the principal of the loan, the total interest on the principal and number of months in loan period respectively. EMI is given by the formula

$$\text{EMI} = \left(\frac{P+I}{n}\right)$$

Reducing-Balance Method or Amortization Formulas

When one is amortizing a loan, at the beginning of any period, the principal outstanding is the present value of the remaining payments. Using this fact, we obtain the formulas in table that describe the amortization of an interest bearing loan of ₹ P, at a rate i per period by n equal payments of ₹ R each and such that a payment is made at the end of each period.

Table-Amortization Formulas

1. Periodic payment or Instalment

$$R = P\left(\frac{i}{1-(1+i)^{-n}}\right) = \frac{P}{a_{\overline{n}|i}}$$

2. Principal outstanding at the beginning of k^{th} period = $R\, a_{\overline{n-k+1}|\, i}$

$$= R\left[\frac{1-(1+i)^{-n+k-1}}{i}\right]$$

3. Total interest paid = nR - P

   Where P= amount of the loan

   R= size of equal payment

   i = rate per period

   n = number of equal payments

Example 12

Mr. X takes a loan of ₹ 2,00,000 with 10% annual interest rate for 5 years. Calculate EMI under Flat Rate system.

Solution: We are given that

$P = ₹\ 2,00,000$

$I = \frac{10}{100} \times 2,00,000 \times 5 = ₹\ 1,00,000$

$n = 5$ years $= 5 \times 12 = 60$

EMI is given by the formula

$$EMI = \left(\frac{P+I}{n}\right)$$

$$EMI = \left(\frac{2,00,000+1,00,000}{60}\right)$$

$$= \frac{3,00,000}{60} = ₹\ 5000$$

Example 13

A couple wishes to purchase a house for ₹ 10,00,000 with a down payment of ₹ 2,00,000. If they can amortize the balance at 9% per annum compounded monthly for 25 years, what is their monthly payment? What is the total interest paid?

Given $a_{\overline{300}|0.0075} = 119.1616$,

Solution: The monthly payment R needed to pay off the balance ₹ 8,00,000 at 9% per annum compounded monthly for 25 years (300 months) is given by

$$R = \frac{P}{a_{\overline{n}|i}}$$

$$= \frac{8,00,000}{a_{\overline{300}|0.0075}} = \frac{8,00,000}{119.1616} = ₹\,6713.57$$

The total interest paid = nR-P

= (6713.57)(300)-8,00,000

= ₹ 12,14,071

Example 14

Mr. M borrowed ₹ 10,00,000 from a bank to purchase a house and decided to repay by monthly equal instalments in 10 years. The bank charges interest at 9% compounded monthly. The bank calculated his EMI as ₹ 12,668. Find the principal and interest paid in first year?

[Given $a_{\overline{108}|0.0075} = 73.83916$]

Solution: Principal left unpaid after one year (12 payments)

= present value of remaining 108 payments = $R\ a_{\overline{n}|i}$

Where R =12,668, n=108 and i = $\frac{0.09}{12}$ = 0.0075

$$= 12{,}668 \times a_{\overline{108}|0.0075}$$

= 12,668 x 73.83916= ₹ 9,35,395

Principal paid during first year = 10,00,000 – 9,35,395 = ₹ 64,605

Interest paid during first year

= {12,668 x 12) – 64,605

= ₹ 87,411

Exercise 7.3

1. Mohan takes a loan of ₹ 5,00,000 with 8% annual interest rate for 6 years. Calculate EMI under Flat-Rate system.
2. XYZ company borrows ₹ 3,00,000 with 7% annual interest rate for 4 years. Calculate EMI under Reducing Balance method.
3. Rajesh borrows ₹ 6,00,000 with 9% annual interest rate for 5 years. Calculate EMI under Reducing Balance method.
4. A person amortizes a loan of ₹ 1,50,000 for a new home by obtaining a 10 year mortgage at the rate of 12% compounded monthly. Find
   (i) The monthly payments (ii) Total interest paid

   [Given $a_{\overline{120}|0.01} = 69.6891$]
5. A couple wishes to purchase a house for ₹ 12,00,000 with a down payment of ₹ 2,50,000. If they can amortize the balance at 9% per annum compounded monthly for 20 years
   (i) What is their monthly payment₹ (ii) What is the total interest paid?

   [Given $a_{\overline{240}|0.0075} = 111.1449$]

7.4 Nominal and Effective Rate of Interest:

Nominal Rate of Interest: The announced or stated rate of interest is called nominal rate of interest.

Effective Rate of Interest: The actual rate by which the money grows during each year is called the effective rate of interest.

Relation between effective rate of interest and nominal rate of interest:

let r be the nominal rate of interest converted m times in a year and r_{eff} be the effective rate of interest.

Then i = $\frac{r}{m}$.

Then the principal P amounts in one year to = P $(1 + i)^m$

Since an effective rate is the actual rate compounded annually, therefore at the effective rate r_{eff}, the principal P amounts in one year to P (1 + r_{eff}). Thus,

$$P\,(1 + r_{eff}) = P\,(1 + i)^m$$

$$1 + r_{eff} = (1 + i)^m$$

$$r_{eff} = (1 + i)^m - 1 = (1 + \frac{r}{m})^m - 1$$

If r is compounded continuously, then

$$r_{eff} = \lim_{m \to \infty} \left[\left(1 + \frac{r}{m}\right)^m - 1\right]$$

$$= \lim_{m \to \infty} \left(1 + \frac{r}{m}\right)^m - 1$$

$$= \lim_{m \to \infty} \left[\left(1 + \frac{r}{m}\right)^{\frac{m}{r}}\right]^r - 1$$

Let $\frac{r}{m} = x$, then as $m \to \infty \Rightarrow x \to 0$

Then $r_{eff} = \left[\lim_{x \to 0} (1 + x)^{\frac{1}{x}}\right]^r - 1$

$$= e^r - 1$$

Hence,

Relation between the nominal rate and effective rate

$$r_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

where r_{eff} = effective rate of interest

r = nominal rate of interest

m = number of conversion periods per year

In case of continuous compounding of nominal rate r, the effective rate of interest is

$r_{eff} = e^r - 1$

where r_{eff} = effective rate of interest

r = nominal rate of interest

Example 15

Mr X took a loan of ₹ 2,000 for 6 months. Lender deducts ₹ 200 as interest while lending. Find the effective rate of interest charged by lender.

Solution: Since the money Lender deducts ₹ 200 as interest while lending a loan of ₹ 2000 for 6 months, therefore ₹ 200 may be treated as interest on ₹ 1800 for 6 months. Consequently, interest rate per six months is

$$i = \frac{200}{1800} = \frac{1}{9}$$

Thus, the equivalent effective rate of interest, r_{eff} is given by

$$r_{eff} = (1 + i)^2 - 1$$

$$= (1 + \frac{1}{9})^2 - 1 = 0.23456$$

$$= 23.45\ \%$$

Example 16

What effective rate is equivalent to a nominal rate of 8% converted quarterly?

Solution: When compounded quarterly we have r = 0.08 and m = 4

Using formula, the effective rate r_{eff} is equivalent to a nominal rate is given by

$$r_{eff} = (1 + \frac{r}{m})^m - 1$$

$$= (1 + \frac{0.08}{4})^4 - 1 = (1.02)^4 - 1$$

$$= 1.0824 - 1 = 0.0824 \text{ or } 8.24\ \%$$

Thus, the effective rate is 8.24%. This means that the rate 8.24% compounded annually yields the same interest as the nominal rate 8% compounded quarterly.

Example 17

Mr. Y has two investment options - either at 10% per annum compounded semi-annually or 9.5 % per annum compounded continuously. Which option is preferable and why?

Solution: When compounded semi-annually we have r = 0.10, m = 2

Now, $r_{eff} = (1 + \frac{r}{m})^m - 1$

$$= (1 + \frac{0.10}{2})^2 - 1$$

$$= 0.1025 \text{ or } 10.25\ \%$$

when compounded continuously

$$r_{eff} = e^r - 1 = e^{0.095} - 1$$

$$= 0.0996 = 9.96\ \%$$

Thus, the first investment is preferable.

Example 18:

Find the effective rate of interest equivalent to a nominal rate of 6% compounded (i) Semi-annually (ii) Quarterly (iii) Continuously

Solution:

(i) When compounded semi-annually

We have r = 0.06 and m = 2

$$r_{eff} = (1 + \frac{r}{m})^m - 1 = (1 + \frac{0.06}{2})^2 - 1$$

$$= 0.0609 \text{ or } 6.09\ \%$$

(ii) When compounded quarterly

We have r = 0.06 and m = 4

$$r_{eff} = (1 + \frac{r}{m})^m - 1$$

$$= (1 + \frac{0.06}{4})^4 - 1$$

$$= 0.0613 \quad \text{or } 6.13\ \%$$

(iii) When compounded continuously

$r_{eff} = e^r - 1 = e^{0.06} - 1$

$= 1.0618 - 1$

$= 0.0618$ or $6.18\ \%$

EXERCISE 7.4

1. What is the effective annual rate of interest compounding equivalent to a nominal rate of interest 5% per annum compounded quarterly?
2. Which is the better investment, 3% per year compounded monthly or 3.1% per year compounded quarterly?
3. What effective rate of interest is equivalent to a nominal rate of 8% converted quarterly?
4. To what amount will ₹ 12000 accumulate in 12 years if invested at an effective rate of 5%?
5. Which yields more interest: 8% effective or 7.8% compounded semi-annually?

7.5 Compound Annual Growth Rate

Meaning of Compound Annual Growth Rate

Compound annual growth rate (CAGR) depicts the cumulative performance of a particular variable over a period of time via compounding effect. It is often used to evaluate the performance of different investments by an individual or enterprise through annual rate of return. The basic concept of compound growth rate can be explained with the help of following example:

If you had invested ?1,000, and it grew at a compound rate of 10% annually,

Year 1: ₹ 1,000 + (1,000 x 10%) = ₹ 1,100

Year 2: ₹ 1,100 + (1,100 x 10%) = ₹ 1,210

Year 3: ₹ 1,210 + (1,210 x 10%) = ₹ 1,331

Year 4: ₹ 1,331 + (1,331 * 10%) = ₹ 1,464.10

So, the amount would be worth ₹ 1,464 after 4 years.

Formula for calculation of CAGR

$$\textbf{CAGR} = \left[\left(\frac{EV}{SV}\right)^{\frac{1}{n}} - 1\right] \times 100$$

where: EV = Investment's ending value

SV = Investment's starting value

n = Number of investment periods (months, years, etc.)

Example 19

Assume an investment's starting value is ₹ 10,000 and it grows to ₹ 60,000 in 4 years. Calculate CAGR.

Solution:

$$\text{CAGR} = \left[\left(\frac{60000}{10000}\right)^{\frac{1}{4}} - 1\right] \times 100$$

CAGR = (1.56508-1) x 100

Hence, CAGR = 56.50%

IMPORTANT POINTS

- CAGR is expressed in percentage
- CAGR can be used to compare historical returns in different investment portfolios
- CAGR eliminates the effects of volatility on periodic investments

Difference between Average Annual Growth rate and Compound Annual Growth Rate

Average Annual Growth Rate is calculated by dividing the cumulative return by the number of years. It usually inflates the results. Compound Annual Growth Rate is determined by compounding effect on the return or any variable taken into consideration. Many investors prefer CAGR because it smoothens out the volatile nature of year-by-year growth rates and provides more accurate measure of performance as compared to Average Annual Growth rate.

Use of Compound Annual Growth Rate

The CAGR can be used to calculate the average growth of a single investment. As we know, due to market volatility, the year-to-year growth of an investment is likely to appear uneven. For example, an investment may increase in value by 9% in one year, decrease in value by 3% the second year and increase in value by 5% in the next. CAGR helps smooth returns when growth rates are expected to be volatile and inconsistent.

CAGR is also used to track the performance of various business measures of one or multiple companies alongside one another. For example, over a five-year period, a Retail Store's market share CAGR was 1.75%, but its customer satisfaction CAGR for the same period was -0.51%. Thus, comparing the CAGRs of measures within a company reveals its strengths and weaknesses.

Example 20:

Calculate CAGR of unit sales on the basis of given information:

Year	2012	2013	2014	2015	2016
Sales	53,000	60,786	73,450	86,000	105,000

Solution:

EV= 105,000 units SV= 53,000 units n= 4

CAGR = $\left[\left(\frac{EV}{SV}\right)^{\frac{1}{n}} - 1\right] \times 100$

= $\left[\left(\frac{1,05,000}{53000}\right)^{\frac{1}{4}} - 1\right] \times 100$

= $[(1.9811)^{\frac{1}{4}} - 1] \times 100$

= [0.18639]x100 =18.63%

Example 21:

Suppose a person invested ₹ 15,000 in a mutual fund and the value of investment at the time of redemption was ₹ 25000. If CAGR for this investment is 8.88%. Calculate the number of years for which he has invested the amount?

Solution:

EV= ₹ 25000 SV= ₹ 15000 CAGR= 8.88% n=?

$$CAGR = \left[\left(\frac{EV}{SV}\right)^{\frac{1}{n}} - 1\right] \times 100$$

$$8.88 = \left[\left(\frac{25,000}{15,000}\right)^{\frac{1}{n}} - 1\right] \times 100$$

$$0.0888 + 1 = (1.666)^{\frac{1}{n}}$$

$$1.0888 = (1.666)^{\frac{1}{n}}$$

$$\log(1.0888) = \frac{1}{n}\log(1.666)$$

$$n = \frac{\log(1.666)}{\log(1.0888)} = \frac{0.2216}{0.0369} = 6.005 \simeq 6 \text{ years}$$

Exercise 7.5

1. An investment has a starting value of ₹ 5000 and it grows to ₹ 25,000 in 4 years. What will be its CAGR?
2. An investment has a starting value of ₹ 2000 and it grows to ₹ 18,000 in 3 years. What will be its CAGR?
3. Calculate CAGR from the following data

Year	2015	2016	2017	2018
Revenue(?)	3,00,000	3,50,000	4,00,000	4,50,000

4. Mr. Kumar has invested ₹ 20,000 in year 2014 for 5 years. If CAGR for that investment turned out to be 11.84%. What will be the end balance?
5. Mr. Naresh has bought 200 shares of City Look Company at ₹ 100 each in 2015. After selling them he has received ₹ 30,000 which accounts for 22.47% CAGR. Calculate the number of years for which he was holding the shares.

7.6 Stock, shares and Debentures:

To start a big business or an industry a large amount of money is needed. It is beyond the capacity of one or two persons to arrange such a huge amount. However, some persons associate together to form a company. They, then, draft a proposal, issue a prospectus (in the name of the company) explaining the plan of the project and invite the public, to invest money in this project. They, thus pool up the funds from the public, by assigning them shares of the company.

Important facts and formulae

Stock capital: The total amount of money needed to run the company is called the stock capital.

Shares or Stock: The whole capital is divided into small units, called shares or stock.

For each investment, the company issues a share certificate, showing the value of each share and the number of shares held by a person. The person who subscribes in stock or shares is called a shareholder or stock holder.

For example: Reliance Industries Ltd., incorporated in the year 1973, is operating in Diversified sector. Company has reported net profit after tax of ₹ 14,819.00 Crore in latest quarter. Reliance Industries Ltd. share price moved up by 0.37% from its previous close of ₹ 2,002.85. Reliance Industries Ltd. stock last traded price is ₹ 2,007.10. As on 31-12-2020, the company has a total of 676.21 Crore shares outstanding.

Explanation: Reliance Industries Ltd. is engaged in issue of Equity Shares. The cost of 1 equity share of this company is ₹ 2007.10 as recorded on 31.12.2020. Till this date, the company carries with itself 676.21 crore shares outstanding.

For example: The board of directors of the UCO Bank, on 7th April 2021, approved the proposal for the issue of equity shares on preferential basis to the Government of India against capital infusion of ₹ 2,600 crore.

Explanation: UCO Bank issued preference shares worth ₹ 2,600 crore to the Government on 7th April 2021. This means that the Government would carry all the preferential rights in the company i.e. payment of preference dividend, right to participate in meetings etc. Also, if the Bank incur losses, then Government will be paid first before equity shares because they own preference shares.

Debentures: The word 'debenture' is a derivation of the Latin word 'debere' which means to borrow or loan. Debentures are written instruments of debt that companies issue under their common seal. They are similar to a loan certificate.

Debentures are issued to the public as a contract of repayment of money borrowed from them. These debentures are for a fixed period and a fixed interest rate that can be paid yearly or half-yearly.

For example: L&T Finance Limited came up with public issue of secured, redeemable non-convertible debentures of face value of ₹ 1,000 each for an amount of ₹ 500 Crore on 16th December2019.

Explanation: L&T Limited issued debentures to general public on 16th December 2019 worth ₹ 500 crore. The face value of Debenture is ₹ 1000 per debenture. These debentures are backed by some fixed assets in the form of security and shall be redeemable after said period. Also, these debentures, being non-convertible means that they cannot be converted into preference shares or equity shares.

Dividend: The annual profit distributed among shareholders is called dividend. Dividend is usually paid annually as per share or as a percentage.

Face Value: The original value of a share or stock printed on the share certificate is called its face value or nominal value or par value. The dividend is calculated as a percentage of face value.

Market value: The stocks of different companies are sold and bought in the open market through brokers at stock-exchanges. A share or stock is said to be

(i) at premium or above par, if its market value is more than its face value.

(ii) At par, if its market value is the same as its face value.

(iii) At discount, if its market value is less than its face value.

Brokerage: The broker's charge is called brokerage.

(i) when stock is purchased, brokerage is added to the cost price.

(ii) when stock is sold, brokerage is subtracted from the selling price.

Remember:

(i) The face value of a share always remains the same.

(ii) The market value of a share changes from time to time.

(iii) Dividend is always paid on the face value of a share.

(iv) Number of shares held by a person

$$= \frac{Total\ investment}{Investment\ in\ one\ share} = \frac{Total\ income}{Income\ from\ one\ share} = \frac{Total\ face\ value}{Face\ value\ of\ one\ share}$$

Features of Equity Shares:

- Equity Shares are permanent in nature.
- Equity shareholders are the owners of the company, and also bear the highest risk.
- They are transferable, i.e. ownership of equity shares can be transferred with or without consideration to another person.
- Dividend payable to equity shareholders is an appropriation of profit.
- Equity shareholders may get a fixed or a fluctuating rate of dividend.
- Equity shareholders have the right to participate in and control the affairs of an organization.
- The liability of equity shareholders is limited to the extent of their investment in the company.

Features of Debentures

- Debentures are the instruments of debt, which means that debenture holders become creditors of the company.
- Debentures are a certificate of debt, with the date of redemption and the amount of repayment mentioned on it. This certificate is also known as a Debenture Deed.
- Debentures have a fixed rate of interest, and such interest amount is payable yearly or half-yearly.
- Debenture holders are not entitled to any voting rights. This is because they are not instruments of equity, so debenture holders are not owners of the company, only creditors.

The interest payable to these debenture holders is a charge against the profits of the company. So these payments have to be made even in case of a loss.

Example 22

Find the cost of

(i) ₹ 7200, 8% stock at 90

(ii) ₹ 4500, 8.5% stock at 4 premium

(iii) ₹ 6400, 10% stock at 15 discount

Solution:

(i) Cost of ₹ 100 stock= ₹ 90

Cost of ₹ 7200 stock = ₹ ($\frac{90}{100}$ x 7200) = ₹ 6480

(ii) Cost of ₹ 100 stock = ₹ (100 + 4) = ₹ 104

Cost of ₹ 4500 stock =₹ ($\frac{104}{100}$ x 4500) = ₹ 4680

(iii) Cost of ₹ 100 stock = ₹ (100 – 15) = ₹ 85

Cost of ₹ 6400 stock = ₹ ($\frac{85}{100}$x 6400) = ₹ 5440

Example 23:

Which is better investment

7.5% stock at 105 or 6.5% stock at 94

Solution: Let the investment in each case be ₹ 105 x 94

Case I: 7.5% stock at 105

On investing ₹ 105, income= ₹ $\frac{15}{2}$

On investing ₹ (105 x 94) income

= ₹ ($\frac{15}{2}$ x $\frac{1}{105}$ x 105 x 94)

= ₹ 705

Case II: 6.5% stock at 94

on investing ₹ 94, income = ₹ $\frac{13}{2}$

On investing ₹ (105 x 94), income

= ₹ ($\frac{13}{2}$ x $\frac{1}{94}$ x105 x 94)

=₹ 682.50

Clearly, the income from 7.5% stock at 105 is more.

Hence, the investment in 7.5% stock at 105 is better.

Example 24

Find the cost of 96 shares of ₹ 10 each at $\frac{3}{4}$ discount, brokerage being ¼ per share.

Solution: Cost of 1 share = ₹ [(10- $\frac{3}{4}$)+ ¼]

= ₹ $\frac{19}{2}$

Cost of 96 shares = ₹ ($\frac{19}{2}$ x 96)

= ₹ 912

Example 25

A man sells ₹ 5000, 12% stock at 156 and invests the proceeds partly in 8% stock at 90 and 9% stock at 108. He thereby increases his income by ₹ 70. How much of the proceeds were invested in each stock₹

Solution: S.P. of ₹ 5000 stock

= ₹ ($\frac{156}{100}$ x 5000)

= ₹ 7800

Income from this stock

$$= ₹ (\frac{12}{100} \times 5000) = ₹\ 600$$

Let investment in 8% stock be 's' and that in 9% stock = 7800 - s

Therefore $(s \times \frac{8}{90}) + (7800 - s) \times \frac{9}{108} = 600+70$

=> $\frac{4s}{45} + \frac{7800-s}{12} = 670$

=> $16s + 117000 - 15s = 670 \times 180$

=> $s = 3600$

Therefore, money invested in 8% stock at 90 = ₹ 3600

Money invested in 9% at 108

= ₹ (7800-3600)

= ₹ 4200

Exercise 7.6

1. Find the cash required to purchase ₹ 3200, 7 ½ % stock at 107 (brokerage ½ %)
2. Find the cash realised by selling ₹ 2440, 9.5 % stock at 4 discount(brokerage ¼%)
3. Which is better investment 11% stock at 143 or 9 ¾% stock at 117
4. Find the income derived from 88 shares of ₹ 25 each at 5 premium, brokerage being ¼ per share and the rate of dividend being 7 ½ % per annum. Also find the rate of interest on the investment.
5. A man buys ₹ 25 shares in a company which pays 9% dividend. The money invested is such that it gives 10% on investment. At what price did he buy the shares?

7.7 Depreciation

The decrease in the value of the assets such as building machinery and equipment of all kinds is called depreciation.

Scrap value, Residual value or salvage value: The value of a depreciable asset at the end of its useful life is called the scrap value.

Total depreciation or wearing value: The difference between the original cost and the scrap value is called total depreciation.

Book value: The difference between the original cost of the asset and the accumulated depreciation at any given date is called the book value of that asset on that date

Methods of computing the annual depreciation:

We will discuss the following three methods of computing the annual depreciation:

1. Straight line method
2. Sum of the years digit method
3. Written down value method or reducing balance method

Linear or Straight line method:

The linear method of depreciation is the simplest and the most widely used method to calculate the depreciation for fixed assets. Buildings, machinery, computer, automobiles, electronic items are examples of assets that will last for more than one year, but will not last indefinitely. Value of such assets decreases year by year because of passage of time, wear and tear, outdated, accidents etc. The work efficiency of asset decreases and expenses on repairs increases. Under this method, a percentage of original cost is written off every year. As the result of this, the amount of Depreciation is uniform every year. In this chapter, we shall discuss various methods of computing depreciation for a depreciable asset.

According to this method the annual depreciation is given by

$$D = \frac{C-S}{n}$$

Where D = the annual depreciation

C = the original cost of the asset

S = estimated scrap value or salvage value

n = the useful life in years

Remark: In the above formula, C-S is the total depreciation.

It should be noted that:

1. When rate of depreciation is given with the words per annum (e.g. 10% p.a.) and the date of acquisition is given then Depreciation is charged only for the period for which the asset is held.
2. When the date of acquisition is not given, then depreciation is charged for full year.
3. When rate of depreciation is given without the words per annum, then depreciation is charged for the full year.

(i) It is a simple method of calculating the Depreciation.

(ii) In this method, asset can be depreciated up to the estimated scrap value.

(iii) In this method, it is easy to know the amount of Depreciation as it is uniform every year.

Sum of the years digit method: In this method, the fraction of the asset to be depreciated each year is obtained by putting the digit of the year in reverse order over the sum of the digits of the life periods. A greater fraction of the cost of the asset is depreciated in the earlier years of the life of the asset.

Written down value method or reducing balance method: This method is called the constant percentage method or diminishing balance method. In this method, the annual depreciation is a constant percentage of the book value of the depreciated asset at the end of the preceding year.

This constant percentage must be determined so that the book value of the asset at the end of its estimated life is reduced to scrap value. The book value at the end of the n^{th} year is given by

$$S = C\ (1-r)^n$$

Where, S = Book value at the end of n^{th} year

C = original cost of the asset

r = rate of depreciation

Example 26

On 1st April, 2020, Ram purchased a machinery costing ₹ 40,000 and spent ₹ 5,000 on its erection. The estimated effective life of the machinery is 10 years with a scrap value of ₹ 5,000. Calculate the depreciation using the Linear/Straight line method with accounting year ending on 31st March, 2021.

Solution: Annual depreciation = $\frac{C-S}{n}$

$$= \frac{(Cost + Erection\ charges) - Scrap\ value}{Expected\ useful\ life}$$

$$= \frac{40{,}000+5000-5000}{10} = ₹\ 4{,}000 \text{ p.a.}$$

Example 27

A machine costing ₹ 30,000 is expected to have a useful life of 4 years and a final scrap value of ₹ 4000. Find the annual depreciation charge using the straight-line method. Prepare the depreciation schedule.

Solution: We are given that

C = 30,000; n=4; S = 4000

Annual depreciation = $\frac{C-S}{n}$

$$= \frac{30000-4000}{4}$$

= 6500

Depreciated schedule

Year	Annual depreciation (₹)	Accumulated depreciation (₹)	Book Value (₹)
0	0	0	30,000
1	6500	6500	23,500
2	6500	13000	17,000
3	6500	19,500	10,500
4	6500	26,000	4000

Example 28

An asset costing ₹ 10,000 is expected to have a useful life of 4 years and a scrap value of zero. Find the annual depreciation charge using the sum-of- the-years digits method.

Solution: We are given that

C = 10,000 ; n = 4 ; S = 0

The annual depreciation charged each year is determined by putting the digits of the year in reverse order over the sum of the digits of the life periods.

Depreciation schedule

Year	Digit of the year in reverse order	Fraction of the asset to be depreciated	Annual depreciation (₹)	Accumulated depreciation (₹)
1	4	$\frac{4}{10}$	$\frac{4}{10} \times 10000 = 4000$	4000
2	3	$\frac{3}{10}$	$\frac{3}{10} \times 10000 = 3000$	7000
3	2	$\frac{2}{10}$	$\frac{2}{10} \times 10000 = 3000$	9000
4	1	$\frac{1}{10}$	$\frac{1}{10} \times 10000 = 1000$	10000

Example 29

A machine costing ₹ 50,000 depreciates at a constant rate of 8%. What is the depreciation charge for the 8^{th} year. If the estimated useful life of the machine is 10 years, determine its scrap value.

Solution: It is given that C = ₹ 50,000 and r = 0.08

The depreciation charge for the 8^{th} year is obtained by subtracting the book value at the end of the 8^{th} year from the book value at the end of the 7^{th} year

The book value at the end of the 7^{th} year

$= C(1-r)^7 = 50{,}000\ (1\text{-}0.08)^7$

$= 50{,}000\ (0.92)^7$

$= 50{,}000\ (0.5578466)$

= ₹ 27892.33

The book value at the end of the 8^{th} year

$= C(1-r)^8 = 50{,}000\ (1\text{-}0.08)^8$

$= 50000\ (0.92)^8$

$= 50{,}000\ (0.5132188)$

= ₹ 25660.94

Hence depreciation charge for the 8^{th} year

= ₹ 27892.33 – ₹ 25660.94

= ₹ 2231.39

The scrap value of the machine is given by

$S = C(1-r)^{10} = 50{,}000\ (1\text{-}0.08)^{10}$

$= 50{,}000\ (0.92)^{10}$

$= 50{,}000\ (0.4343884)$

= ₹ 21719.42

Exercise 7.7

1. A machine costing ₹ 30000 is expected to have a useful life of 13 years and a final scrap value of ₹ 4000. Find the annual depreciation charge using the straight line method.
2. An asset costing ₹ 15,000 is expected to have a useful life of 5 years and a scrap value of ₹ 3000. Find the annual depreciation charge using the straight-line method.
3. A piece of machinery costing ₹ 10000 is expected to have a useful life of 4 years and a scrap value of zero. Find the annual depreciation charge using the sum- of- the- years digits method.
4. A machine, the life of which is estimated to be 15 years, costs ₹ 40,000. Calculate the scrap value at the end of its life if it is depreciated at a constant rate of 10% per annum.
5. A machine costing ₹ 5000 depreciates at a constant rate of 5%. What is the depreciation charge for the 5^{th} year?
6. A firm bought a machinery for ₹ 7,40,000 on 1^{st} April, 2018 and ₹ 60,000, is spent on its installation. Its useful life is estimated to be of 5 years. It's estimated reliable or scrap value at the end of the period was estimated at ₹ 40,000. Find out the amount of annual depreciation and rate of depreciation.
7. Shiv & Co. purchased a mobile phone for ₹ 21,000 on 1^{st} April, 2019. The estimated life of the mobile phone is 10 years, after which its residual value will be ₹ 1,000 only. Find out the amount of annual depreciation according to linear method.
8. On 1^{st} April, 2015, Dreams Ltd. purchased an AC for ₹ 3,00,000 and incurred ₹ 21,000 towards freight, ₹ 3,000 towards carriage and ₹ 6,000 towards installation charges. It has been estimated that the machinery will have a scrap value of ₹ 30,000 at the end of the useful life which is four years. What will be the annual depreciation and the value of machinery after four years according to linear method?

ANSWERS

EXERCISE 7.1

1. ₹ 4000
2. ₹ 144000
3. 5%
4. ₹ 13,780
5. ₹ 1080
6. ₹ 373.60
7. ₹ 2408.19
8. ₹ 5968.8
9. ₹ 745

Exercise 7.2

1. ₹ 1,171.19
2. ₹ 911.53
3. ₹ 94,671
4. 5.66%
5. ₹ 1,201.20 ₹ 963

EXERCISE 7.3

1. ₹ 10,278
2. ₹ 7,179
3. ₹ 12,455
4. ₹ 2,152.42, ₹ 108290.4
5. ₹ 8547.20, ₹ 1101376.17

EXERCISE 7.4

1. Effective annual rate of interest = 5.09 %
2. Better investment is 3.1 % per year compounded quarterly
3. Effective annual rate of interest = 8.24 %
4. ₹ 21560 approximately
5. First option

EXERCISE 7.5

1. 49.53%
2. 108%
3. 14.47%
4. ₹ 35,000
5. 2 years

EXERCISE 7.6

1. ₹ 3440
2. ₹ 2298
3. 9¾ % stock at 117 is better.
4. ₹ 165, 6.2%
5. ₹ 22.50

EXERCISE 7.7

1. ₹ 2000
2. ₹ 2400
3. ₹ 4000, ₹ 3000, ₹ 2000, ?1000
4. ₹ 8224
5. ₹ 203.50
6. ₹ 1,52,000 p.a.; 19% p.a.
7. ₹ 2,000 p.a.
8. ₹ 75,000 p.a.; ₹ 3,30,000

❑❑❑