Chapter 4
TIME VALUE OF MONEY

4.1 BASICS

A. Concept of Interest: Interest is the remuneration paid by the borrowers of money to the lenders. The excess money paid to the Lender of Funds is called Interest. **Example:** If ₹ 1,00,000 is borrowed for a year, the amount of repayment would be in excess of the amount so borrowed. If say ₹ 1,10,000 is paid back ₹ 10,000 constitutes interest. The reasons behind the payment of Interest are as follows –

1. **Time Value of Money:** Time Value of Money means that the value of a unit of money is different in different time periods. The sum of money received in future is less valuable than it is today. In other words, the present worth of Rupees received after some time will be less than a Rupee received today. Since a Rupee received today has more value, rational investors would prefer Current Receipts to Future Receipts. If they postpone their receipts, they charge some interest.
2. **Opportunity Cost:** The Lender has a choice between using his money in different investments. If the chooses one he forgoes the return from all others. In other words, the Lender incurs an Opportunity Cost due to the possible alternative uses of the lent money.
3. **Inflation:** Most economies generally exhibit inflation. Inflation is a fall in the purchasing power of money. Due to inflation, a given amount of money buys fewer goods in the future than it will now. The Borrower needs to compensate the Lender for this.
4. **Liquidity Preference:** People prefer to have their resources available in a form that can immediately be converted into cash rather than a form that takes time for money to realize.
5. **Risk Factor:** There is always a risk that the Borrower will go bankrupt or otherwise default on the Loan. Risk is a determinable factor in fixing rate of interest. A Lender generally charges more interest rate (Risk Premium) for taking more risk.

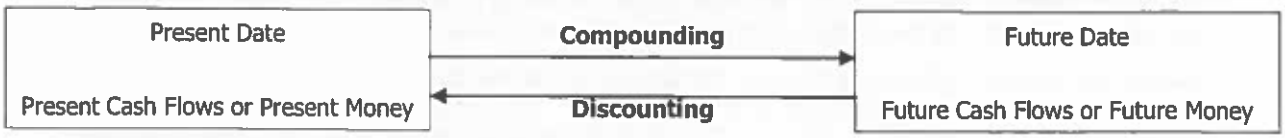
B. Other Terms Involved:

1. **Principal:** Principal is initial value of Lending or Borrowing. In case of Investment, the value of Initial Investment is also called Principal.
2. **Rate of Interest:** The rate at which the interest is charged for a defined length of time for use of principal generally on a periodical basis is known to be the Rate of Interest. Rate of Interest is usually expressed as a percentage. **Example:** If the Interest Rate is 5% per annum, it means that ₹ 5 would be paid as interest, for every ₹ 100 of principal amount in a year.
3. **Accumulated Amount (Balance):** Accumulated Amount is the final value of an investment. It is the sum total of Principal and Interest earned. **Example:** If ₹ 1,00,000 is borrowed for a year at 10% p.a, the amount of interest earned for a year would be ₹ 10,000. At the end of the period, ₹ 1,10,000 would remain on Account. The same is also known as Amount or the balance due.

C. Methods of Analysis: The concept of Time Value of Money helps in arriving at the comparable value of the different rupee amount arising at different points of time into equivalent values of a particular point of time (Present or Future). This can be done by either –

(a) **Compounding** the Present Money to a future date, i.e. finding out **Future Value of Present Money**, or

(b) **Discounting** Future Money to the present date, i.e. finding out **Present Value of Future Money**.



4.2 SIMPLE INTEREST

Simple Interest is the interest calculated as a simple percentage of the original principal amount. The formula relating to Simple Interest are given below –

Simple Interest = P × N × R, where P = Principal Amount. N = Number of years. R = Interest Rate per annum.	**Amount = Principal + Interest** Hence, A = P + (P × N × R), **A = P [1 + (N × R)]**

Example:
Let us say that ₹ 50,000 is invested at Simple Interest of 10% p.a. for 3 years. The amount at the end of 3 years as per the formula = 50,000 [1+ (0.10 × 3)] = 50,000 × 1.3 = ₹ 65,000.

Year	Opening Principal	Interest	Total Interest	Amount
1	50,000	=50,000×10%=5,000	5,000	55,000
2	50,000	=50,000×10%=5,000	10,000	60,000
3	50,000	=50,000×10%=5,000	15,000	65,000

4.3 COMPOUND INTEREST

1. Compounding means that interest is paid both on previous earned interest and as well as on the Principal.
2. Interest due at the end of every payment period is added to the Principal, and Interest on the next payment period is computed on the new Principal.
3. The Time Interval between successive additions of interests is known as Conversion (or Payment) Period. Some Conversion Periods are –

Conversion Period	1 day	1 month	3 months	6 months	12 months
i.e. Compounded	Daily	Monthly	Quarterly	Half–yearly	Annually

4. The amount (Principal + Interest) at the end of every payment period is indicated below –

Payment Period	First	Second	Third	n^{th}
Amount Due =A=	$A_1 = P + PR$ $= P(1 + R)$	$A_2 = A_1 + A_1 \times R$ $= A_1(1 + R)$ $= P(1 + R)^2$	$A_3 = A_2 + A_2 \times R$ $= A_2(1 + R)$ $= P(1 + R)^3$	$A_n = A_{n-1} + A_{n-1} \times R$ $= A_{n-1}(1 + R)$ $= P(1 + R)^n$

Note: Amount under Compound Interest = $\mathbf{P(1 + R)^{NK}}$

Where P = Principal Amount.

N = Number of years.

K = Number of times compounding is done per year, e.g. Monthly (12), Quarterly (4), etc.

R = Interest Rate per payment period = $\frac{\text{Interest Rate p.a.}}{\text{Number of payment periods p.a.}} = \frac{I}{K}$

Additional Points:

(a) **Compound Interest Tables:** Compound Interest Tables as well as Future Value (FV) Tables for $\mathbf{(1 + R)^{NK}}$ at various rates per annum with – (a) annual, (b) monthly, and (c) daily compounding, are available for easy calculation.

(b) **Rule of 72:** In case of Compound Interest, the number 72 provides an interesting approximation. If we divide 72 by the Interest Rate, we can estimate the number of years it takes for the money to double (for or against) us. For example, if interest rate is 12%, it takes (72÷12 =) 6 years approximately for the money to become **double**.

(c) **Simple vs Compound Interest:** The longer the funds are invested, the greater the advantage with Compound Interest than with Simple Interest. The rate of growth is higher in terms of Compound Interest.

Example: Let us say that ₹ 50,000 is invested at Compound Interest of 10% p.a. for 3 years.

Year	Opening Principal	Interest	Amount
1	50,000	=50,000 × 10% = 5,000	55,000
2	55,000	=55,000 × 10% = 5,500	60,500
3	60,500	=60,500 × 10% = 6,050	66,550

1. Amount at the end of n years of the amount P invested at Time 0 at the rate of R is = $\boxed{P(1+R)^n}$
   In the above example, Amount at the end of the Third Year = $50,000(1+0.10)^3$ = ₹ **66,550.**

2. Total Interest for the period = Amount at the end of n years – Opening Principal = $\boxed{P(1+R)^n - P = P[(1+R)^n - 1]}$
   In the above example, Compound Interest for 3 year period = 66,550 – 50,000 = ₹ **16,550.**

4.4 NOMINAL RATE & EFFECTIVE INTEREST RATE

1. **Nominal Rate:** The Annual Compound Interest Rate is called the **Nominal Interest Rate.**

2. **Effective Rate:** When the amount is compounded more than once a year, the actual rate of interest for each year is called the Effective Interest Rate. Effective Rate arises only when there is more than one compounding terms per annum. Effective Interest Rate is computed as $\boxed{E=(1+i)^m-1}$, where m is number of compounding terms per annum. Where Compounding is done more than once during an annum, the Effective Rate > Nominal Rate.

3. **Formula:**

   (a) **Effective Interest Rate** = $\frac{\text{Actual Interest Paid During the Year}}{\text{Opening Principal of the Year}} = \frac{\text{Closing Amount} - \text{Opening Principal}}{\text{Opening Principal of the Year}}$

   (b) If interest is paid "k" times in a year, & "i" is the rate of interest per annum, **Effective Rate of Interest** (E) is given by $E=\left(1+\frac{i}{k}\right)^k-1$

Note: The Concept of Effective Interest Rate arises only where there is more than one compounding terms per annum.

4.5 CONCEPT OF ANNUITY

1. **Meaning:** An **Annuity** is a stream or sequence of regular periodic Cash Flows (either payments made or received) for a specified period of time. Some examples of Annuity Payments are – (a) Recurring Deposit Instalments paid to a Bank, (b) Life Insurance Premium per annum, (c) Sinking Fund Instalments, etc.

2. **Features:**

   (a) Annuity refers to a series of payments and not one payment.

   (b) Amount paid should be constant over the period of annuity.

   (c) Time interval between two consecutive Payments (or Receipts) should be the same.

Year end	Payments/Receipts(₹)	Payments/Receipts(₹)	Payments/Receipts(₹)
1	5000	5000	5000
2	6000	5000	5000
3	4000	–	5000
4	5000	5000	5000
5	7000	5000	5000
Annuity?	Not an annuity, since Cash Flows are **not equal**	Not an annuity, since Cash Flows are **not regular.**	This is an Annuity.

3. **Annuity Regular vs Annuity Immediate:**

Annuity Regular (Generally assumed)	Annuity Immediate
Regular Payments or Receipts are made at the **end** of each year / period.	Payments or Receipts is made at the **beginning** of each year / period.
First Payment or Receipt arises at the end of **Year 1.**	First Payment or Receipt arises immediately, i.e. in **Year 0.**

4.6 CONCEPT OF COMPOUNDING & FUTURE VALUE

1. **Compounding** the present money to a future date involves finding out **future value of present money.**

2. **Future Value: Meaning:** Future Value represents value at the end of n^{th} year. Future Value is the cash value of an investment at some time in the future. It is tomorrow's value of today's money compounded at the rate of interest. **Example:** If ₹ 1000 is invested in a Fixed Deposit that pays you 7% per annum as interest. At the end of the year the amount would be ₹ 1070. This consists of the Original Principal of ₹ 1000 and the interest earned of ₹ 70. ₹ 1070 is the Future Value of ₹ 1000 invested for one year at 7%. Similarly, it can also be concluded that ₹ 1000 today is worth ₹ 1070 in one year's time if the interest rate is 7%.

3. **Future Value Formula:** We know that, $A = P(1+i)^n$. So, the Future Value of a **Single Cash Flow** represented as FV, is given by the Formula, **$FV = CF\ (1+i)^n$;** where CF = Cash Flow.

	Annuity Regular (Year end)			Annuity Immediate (Year beginning)		
Question	Consider a Year end Payment of ₹ 5,000 for 5 years at 10% p.a Interest compounded annually.			Consider a Year beginning Payment of ₹ 5,000 for 5 years at 10% p.a Interest compounded annually.		
Future Value	**Year**	**Payments**	**Future Value**	**Year**	**Payments**	**Future Value**
	1	5000	$5000 \times (1.1)^4 = 7321$	0	5000	$= 5000 \times (1.1)^5 = 8053$
	2	5000	$= 5000 \times (1.1)^3 = 6655$	1	5000	$= 5000 \times (1.1)^4 = 7321$
	3	5000	$= 5000 \times (1.1)^2 = 6050$	2	5000	$= 5000 \times (1.1)^3 = 6655$
	4	5000	$= 5000 \times (1.1)^1 = 5500$	3	5000	$= 5000 \times (1.1)^2 = 6050$
	5	5000	$= 5000 \times (1.1)^0 = 5000$	4	5000	$= 5000 \times (1.1)^1 = 5500$
	Future Value		**₹ 30,526**	**Future Value**		**₹ 33,579**
Formula	$A = CF\left[\frac{(1+i)^n - 1}{i}\right]$			$A = CF\left[\frac{(1+i)^n - 1}{i}\right] \times (1+i)$		
	$= \frac{5000}{0.10}[(1+0.1)^5 - 1] =$ **₹ 30,526**			$\frac{5000}{0.10}[(1+0.1)^5 - 1] \times (1+0.1) =$ **₹ 33,579 [Note]**		

Note: Future Value of Annuity Immediate = Future Value of Regular Annuity × (1+R) **= ₹ 30,526 × 1.1 = ₹ 33,579**

4.7 CONCEPT OF DISCOUNTING & PRESENT VALUE

1. **Present Value:** Present Value (PV), is the amount of money that represents the sum of Principal and Interest, if such amount (say ₹ P) is required to be invested now at a certain rate compounded over a number of time periods at a specified rate for each time period.

   Present Value is the Value today of the money to be received at a future point of time. In the above example ₹ 1070 was to be received at the end of Year 1 after considering interest at 7% p.a. Therefore the Present Value or the Value now of the ₹ 1,070 to be received after 1 year is ₹ 1,000.

   From the formula of Amount under Compound Interest, we know that $A_n = P(1 + R)^n$

   Transposing the above formula & solving for P, we have $P = A_n(1 + R)^{-n}$. So, Present Value= $\frac{A_n}{(1 + R)^n}$

2. **Discounting** future money to the present date involves finding out Present Value of future money. Discounting is the opposite of Compounding and hence, Present Value of Future Cash Flows is given by the following formula –

$$\text{Present Value} = \frac{FV_1}{(1+R)^1} + \frac{FV_2}{(1+R)^2} + \frac{FV_3}{(1+R)^3} + \frac{FV_4}{(1+R)^4} + \ldots\ldots\ldots\ldots + \frac{FV_n}{(1+R)^n}$$

Where 1,2,3,4,....n represent future time periods and FV = Cash Flows arising at those future points of time, and R denotes the Discount Rate / Rate of Interest.

3. **Present Value:** Present Value of a Single Cash Flow is given by – $PV = \frac{CF}{(1+R)^n}$. PV of an Annuity means the Value of the Annuity at present. It represents the current value of the expected Future Cash Flows, at a given rate of interest.

	Annuity Regular (Year end)			**Annuity Immediate (Year beginning)**		
Question	Consider a Year end Payment of ₹ 5,000 for 5 years at 10% p.a Interest compounded annually.			Consider a Year beginning Payment of ₹ 5,000 for 5 years at 10% p.a Interest compounded annually.		
Present Value	**Year**	**Payments**	**Present Value**	**Year**	**Payments**	**Present Value**
	1	5000	$= 5000 \div (1.1)^1 = 4545$	0	5000	Arises now, so PV = 5000
	2	5000	$= 5000 \div (1.1)^2 = 4132$	1	5000	$= 5000 \div (1.1)1 = 4545$
	3	5000	$= 5000 \div (1.1)^3 = 3757$	2	5000	$= 5000 \div (1.1)2 = 4132$
	4	5000	$= 5000 \div (1.1)^4 = 3415$	3	5000	$= 5000 \div (1.1)3 = 3757$
	5	5000	$= 5000 \div (1.1)^5 = 3105$	4	5000	$= 5000 \div (1.1)4 = 3415$
	Present Value		**₹ 18,954**	**Present Value**		**₹ 20,849**
Formula	$PV = CF\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$ $= \frac{5000}{0.10} \times \frac{(1+0.1)^5 - 1}{(1+0.1)^5} =$ **₹ 18,954**			$PV = CF\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] \times (1+i)$ $\frac{5000}{0.10} \times \frac{(1+0.1)^5 - 1}{(1+0.1)^5} \times (1+0.1) =$ **₹ 20,849 [Note]**		
Alternative Formula	$PV = \frac{\text{FV of Annuity Regular}}{(1+R)^n} = \frac{30526}{1.1^5} =$ ₹ 18,954. **Note:** In the example in Page 4.4, FV of Annuity Regular was computed as ₹ 30,526.			$PV = \frac{\text{FV of Annuity Immediate}}{(1+R)^n} = \frac{33579}{1.1^5} =$ **20,849.** **Note:** In the example in Page 4.4, FV of Annuity Immediate was computed as ₹ 33,579.		

Note: Present Value of an Annuity Immediate can also be computed as under –

(a) Compute PV for (n–1) years and then add back the Annuity Amount (relating to Year 0).

(b) PV of Annuity for n–1, i.e. 5–1 = 4 yrs, at 10% = $[5{,}000 \times \frac{(1+0.1)^4 - 1}{0.1 \times (1+0.1)^4}] + 5{,}000 = 15{,}849 + 5{,}000 =$ **₹ 20,849**

4.8 CONCEPT OF PERPETUITY

1. **Meaning:** Perpetuity is a stream of payments or a type of annuity that starts payments on a fixed date and such payments continue forever, i.e. **perpetually**. Thus, Perpetuity is a constant stream of identical annual cash flows with no end, i.e. upto infinity.
2. **Examples:** (a) Dividend on Irredeemable Preference Share Capital, (b) Interest on Irredeemable Debt / Bonds, (c) Scholarships paid perpetually from an Endowment Fund, etc.
3. **Operation:** In a Fund involving perpetual annual Cash Flows, an Initial Fund (Principal) is established first, and the payments will flow from the Fund indefinitely. This means that these periodic payments are effectively the annual interest payments.
4. **Value:**
   (a) Value of a Perpetuity is calculated as its Expected Income Stream ÷ Discount Factor or Market Rate of Interest. Thus, it reflects the expected Present Value of all payments (to be received perpetually).
   (b) The Value of a Perpetuity is **finite** because receipts that are anticipated far in the future have extremely low PV. Also, because the Principal is never repaid, there is no Present Value for the Principal.

   Note: Since Perpetuity is a type of annuity which is unending, its sum or Future Value **cannot** be calculated.

5. **Formula:**

PV of a **Constant** Perpetuity $= \frac{C}{R}$

Where **C** = Cash Flow, i.e. Interest, Dividend, etc. per period.
R = Interest Rate per payment period.

PV of a **Growing** Perpetuity $= \frac{C}{R-G}$

Where **C** = Cash Flow, i.e. Interest, Dividend, etc. for the first period
R = Interest Rate per payment period.
G = Rate of growth in Cash Flows.

Note: A stream of Annual Cash Flows growing at a constant rate forever is known as **Growing** Perpetuity.

6. **Annuity vs Perpetuity:**

Particulars	Annuity	Perpetuity
Meaning	An **Annuity** is a stream of regular periodic cash flows (either payments made or received) for a specified period of time.	Perpetuity is a stream of payments or a type of annuity that starts payments on a fixed date and such payments continue forever, i.e. **perpetually**. Thus, Perpetuity is a constant stream of identical cash flows with no end.
Examples	(a) Recurring Deposit Instalments paid to a Bank, (b) Life Insurance Premium per annum.	(a) Dividend on Irredeemable Preference Share Capital, (b) Interest on Irredeemable Debt / Bonds, (c) Scholarships paid perpetually from an Endowment Fund, etc.
FV	Future Value of Annuity can be computed using Compounding Technique.	Perpetuity is a type of annuity which is unending, its sum or Future Value **cannot** be calculated.

4.9 APPLICATIONS

1. **Sinking Fund:** It is a fund created for a purpose by way of sequence of periodic payments over a period of time at a specified rate. Interest is compounded at the end of every period. The Sinking Fund Payments generally take the form of an Annuity.

The Future Value of the Sinking Fund Annuity = $A(n,i) = A\left[\frac{(1+i)^n - 1}{i}\right]$ (**Note:** This is the same as FV of Annuity)

2. **Leasing:** Leasing is a financial arrangement under which the owner of the asset (Lessor) allows the User of the asset (Lessee) to use the asset for a defined period of time (lease period) for a consideration (Lease Rental) payable over a period of time. The Lease Rentals form an **annuity** as they are fixed payments made at regular intervals. The Present Value of the Lease Rental Annuity (using Formula given above) represents the Cash Down Price of the Lease to the Lessee and Present Value of Lease Income to the Lessor.

3. **Capital Expenditure (Investment Decision):**
   (a) Capital Expenditure means purchasing an asset today (which results in outflow of money at Time 0) in anticipation of benefits (cash inflow) which would flow across the life of the Investment.
   (b) The **Present Value** of Cash Outflows and Inflows (using formula given above) are compared to arrive at the Investment decision.

Particulars	Investment Decision
Present Value of Cash Inflow > Present Value of Cash Outflow	Investment to be made
Present Value of Cash Inflow < Present Value of Cash Outflow	Investment not to be made
Present Value of Cash Inflow = Present Value of Cash Outflow	Indifference Point

4. **Valuation of Bond:** Bonds are long–term debt securities, which enables Purchasers to receive periodic interest payments until maturity at which they receive face value of the bond. Value of Bond = Present Value of Interest Payments + Present Value of Maturity payments. (to be found using the formula for Present Value)

5. **Compounded Annual Growth Rate (CAGR):** This is given by the following formula –

$$CAGR = \sqrt[n]{\frac{\text{Total Return} + \text{Initial Investment}}{\text{Initial Investment}}} - 1$$ [Inverse of Compound Interest Formula]

OR $= \left[\frac{\text{Total Return} + \text{Initial Investment}}{\text{Initial Investment}}\right]^{1/n} - 1$ where, "n" represents the period of holding.

6. **Effect of Inflation:** Since Cash–Flows are expressed in Nominal Terms (after including the impact of inflation), the discount rate chosen should also be Nominal Discount Rate, i.e. Real Discount Rate adjusted for inflation.

Hence, $(1 + R_N) = (1 + R_R) \times (1 + I)$

Where, R_N = Nominal Discount Rate and I = Inflation Rate

R_R = Real Discount Rate (Without effects of inflation)

Summary of Formulae

	Simple Interest	Compound Interest
Interest	$P \times N \times R$	$P(1+R)^n - P = P[(1+R)^n - 1]$
Amount	$A = P\,[1 + (N \times R)]$	$A = P(1 + I/K)^{NK}$
Principal	$P = A \div [1 + (N \times R)]$	$P = A \div (1 + I/K)^{NK}$

Effective Interest Rate $= \frac{\text{Actual Interest Paid During the Year}}{\text{Opening Principal of the Year}} = \frac{\text{Closing Amount} - \text{Opening Principal}}{\text{Opening Principal of the Year}} = E = \left(1 + \frac{i}{k}\right)^k - 1$

	Annuity Regular (Year end)	Annuity Immediate (Year beginning)
Present Value (PV)	$PV = CF\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$	$PV = CF\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] \times (1 + i)$
Future Value (FV)	$A = CF\left[\frac{(1+i)^n - 1}{i}\right]$	$A = CF\left[\frac{(1+i)^n - 1}{i}\right] \times (1 + i)$
PV using Factors	PV = CF × PVAF @ r% for n periods	PV = CF × [PVAF @ r% for (n–1) periods + 1]
FV using Factors	FV = CF × [FVAF @ r% for (n–1) periods + 1]	FV = CF × FVAF @ r% for n periods

PV of a **Constant** Perpetuity $= \frac{C}{R}$

Where **C** = Cash Flow, i.e. Interest, Dividend, etc. per period.
R = Interest Rate per payment period.

PV of a **Growing** Perpetuity $= \frac{C}{R - G}$

Where **C** = Cash Flow, i.e. Interest, Dividend, etc. for the first period
R = Interest Rate per payment period.
G = Rate of growth in Cash Flows.

Illustrations

4.1 SIMPLE INTEREST

Illustration 1: Simple Interest Basics

Answer the Following –

(a) How much interest will be earned on ₹ 2,000 at 6% simple interest for 2 years?

Solution: Required Interest Amount is given by $I = P \times i \times n$

$= 2,000 \times 0.06 \times 2 = ₹ 240$

(b) X deposited ₹ 50,000 in a bank for two years with the interest rate of 5.5% p.a. How much interest would she earn? What would be the Final Value of the Deposit?

Solution:

Required Interest Amount is given by $I = P \times i \times n$

$= ₹ 50,000 \times 0.055 \times 2 = ₹ 5,500$

Final value of investment is given by $A = P(1 + in)$

$= ₹ 50,000 \left(1+\frac{5.5}{100}\times 2\right) = ₹ 50,000 \left(1+\frac{11}{100}\right)$

$= ₹ 50,000 \times \frac{111}{100} = ₹ \mathbf{55,500}$

Alternatively, $A = P + I = ₹ (50,000 + 5,500) = ₹ \mathbf{55,500}$

(c) Rahul deposited ₹ 1,00,000 in his bank for 2 years at simple interest rate of 6%. How much interest would he earn? How much would be the final value of deposit?

Solution:

(a) Required interest amount is given by $I = P \times i \times n$

$= ₹ 1,00,000 \times \frac{6}{100} \times 2$

$= ₹ 12,000$

(b) Final value of deposit is given by

Amount = Principal + Interest

$= ₹ (1,00,000 + 12,000)$

$= ₹ 1,12,000$

Illustration 2: Simple Interest Solving for Missing Variables

Answer the Following –

Find the rate of interest if the amount owed after 6 months is ₹ 1,050, borrowed amount being ₹ 1,000.

Solution: We know $A = P + (P \times i \times n)$

i.e. $1,050 = 1,000 + (1,000 \times i \times 6/12)$

$50 = 500i \;;\; i = 1/10 = 10\%$

Rahul invested ₹ 70,000 in a bank at the rate of 6.5% p.a. S.I.. He received ₹ 85,925 after the end of term. Find out the period for which sum was invested by Rahul.

Solution: We know $A = P(1 + in)$

i.e. $85,925 = 70,000 \left(1+\frac{6.5}{100} \times n\right)$

$\frac{85,925}{70,000} = \frac{100 + 6.5n}{100}$

$\left(\frac{85,925}{70,000} \times 100\right) - 100 = 6.5n$

$6.5n = 22.75 \;;\; n = 3.5 \;\therefore$ time = 3.5 years

Kapil deposited some amount in a bank for 7½ years at the rate of 6% p.a. simple interest. Kapil received ₹ 1,01,500 at the end of the term. Compute initial deposit of Kapil.

Solution: We know $A = P(1 + in)$

$1,01,500 = P\left(1+\frac{6}{100}\times\frac{15}{2}\right)$

$1,01,500 = P \times 1+\frac{45}{100}$

$1,01,500 = P \times \left(\frac{145}{100}\right)$

$P = \frac{1,01,500 \times 100}{145} = ₹ 70,000$

$\therefore$ Initial deposit of Kapil = ₹ 70,000

A sum of ₹ 46,875 was lent out at simple interest and at the end of 1 year 8 months the total amount was ₹ 50,000. Find the rate of interest percent per annum.

Solution: We know $A = P(1 + in)$

i.e. $50,000 = 46,875 \left(1 + i \times 1\frac{8}{12}\right)$

$\frac{50,000}{46,875} = 1 + \frac{5}{3}i$

$(1.067 - 1) \times \frac{3}{5} = i$

$i = 0.04$; rate = 4%

Illustration 3: Simple Interest Solving for Missing Variables

What sum of money will produce ₹ 28,600 as an interest in 3 years and 3 months at 2.5% p.a. simple interest?

Solution:

$I = P \times i \times n$

$28600 = P \times \frac{2.5}{100} \times 3\frac{3}{12}$

$28600 = P \times \frac{2.5}{100} \times \frac{13}{4}$

$28600 = P \times \frac{32.5}{400}$

$P = \frac{28,600 \times 400}{32.5}$ = **₹ 3,52,000**

∴ ₹ 3,52,000 is to be invested to produce ₹ 28,600 interest in 3 years and 3 months at 2.5% p.a. simple interest

In what time will ₹ 85,000 amount to ₹ 1,57,675 at 4.5% p.a.?

Solution:

$A = P(1 + in)$

$1,57,675 = 85,000 (1 + 0.045 \times n)$

$\frac{1,57,675}{85,000} = 1 + 0.045n$

$0.045n = \frac{1,57,675}{85,000} - 1$

$n = \frac{0.855}{0.045}$ = **19 years**

∴ ₹ 85,000 will amount to ₹ 1,57,675 at 4.5% p.a. simple interest rate in 19 years.

4.2 COMPOUND INTEREST

Illustration 4: Compound Interest

Saina deposited ₹ 1,00,000 in a nationalized bank for three years. If the rate of interest is 7% p.a., calculate the interest that bank has to pay to Saina after three years if interest is compound annually. Also calculate the amount at the end of third year.

Solution:

Year	Opening Principal	Interest = P × i × t	Closing Principal
1	1,00,000	1,00,000× 0.07 × 1 = 7,000	1,07,000
2	1,07,000	1,07,000× 0.07 × 1 = 7,490	1,14,490
3	1,14,490	1,14,490×0.07× 1= 8014.30	1,22,504.30
Total		**22,504.30**	

Note: The Calculation can also be found out as follows –

Amount at the End of the Period = $P(1+i)^n$ = $1,00,000(1+07)^3$ = 1,00,000 (1.225043) = 1,22,504.30

Total Interest = Closing Principal – Opening Principal = ₹ 22,504.30

Illustration 5: Compound Interest – Multiple Compounding

₹ 2000 is invested at annual rate of interest of 10%. What is the amount after two years if compounding is done (a) Annually (b) Semi–annually (c) Quarterly (d) Monthly.

Solution:

In case Compounding is done more than once a year the Formula to be used is as follows –

$A = P(1+I)^N$,

Where, P = Amount Invested or Principal (P = 2000 Given)
I = i/m ;
N is the number of compounding terms in the period=mn,
m is the number of Compounding in one year

(a) **Annual Compounding**

Since the interest is compounded yearly the number of conversion periods n in 2 years are 2, n=2. i=0.10

$A = P(1 + i)^n$

$A = ₹ 2000 (1 + 0.1)^2$

$= ₹ 2000 \times (1.1)^2 = ₹ 2000 \times 1.21 =$ **₹ 2,420**

(b) **Semi–Annual Compounding**

In case of Semi–Annual Compounding

m= no. of compounding terms in 1 year = 2

N = no. of compounding terms in 2 years = mn = 2 x 2 = 4

I = i/2 = 0.1/2 = 0.05

$A = 2000 (1 + 0.05)^4 = 2000 \times 1.2155 =$ **₹ 2,431**

(c) **Quarterly Compounding**	(d) **Monthly Compounding**
In case of Quarterly Compounding m= no. of compounding terms in 1 year = 4 N = no. of compounding terms in 2 years = mn = 2 × 4 = 8 I = i/4 = 0.1/4 = 0.025 A = 2,000 $(1 + 0.025)^8$ = 2,000 × 1.2184= ₹ **2,436.80**	In case of Monthly Compounding m = no. of compounding terms in 1 year = 12 N = no. of compounding terms in 2 years = mn = 2 ×12=24 I = i/12 = 0.1/12 = 0.00833 A = 2000 $(1 + 0.00833)^{24}$ = 2000 × 1.22029 = ₹ **2,440.5893**

Illustration 6: Compound Interest – Multiple Compounding

Determine the compound amount and compound interest on ₹ 1000 at 6% compounded semi-annually for 6 years. Given that $(1 + i)^n = 1.42576$ for i = 3% and n = 12.

Solution:

In case of semiannual compounding
m= no. of compounding terms in 1 year = 2
N = no. of compounding terms in 2 years = mn = 2 x 6 = 12
I = i/2 = 0.06/2 = 0.03
P = 1000

Amount at the End of n years = A= P $(1 + I)^N$ = ₹ 1000 $(1 + 0.03)^{12}$ = 1000 x 1.42576 = ₹ 1425.76

Compound Interest = Amount – Opening Principal = 1425.76 – 1000 = ₹ 425.76

Illustration 7: Compound Interest – Multiple Compounding

Compute the compound interest on ₹ 4,000 for 1 ½ years at 10% per annum compounded half-yearly.

Solution:

A = P $(1 + i)^n$
P = ₹ 4,000.
m = 2 (in case of Semi – Annual Compounding)
I = i/m = 0.1 / 2 = 0.05
N = nm = 1.5 × 2 = 3

Amount at the End of 3 Compounding Terms A = 4,000 $(1 + 0.05)^3$ = 4,630.50
= 4,630.50 – 4,000 = ₹ 630.50

Note:

1. Alternatively, C.I. (Compound Interest for N Periods) = P[$(1 + i)^n$ – 1]
2. The Compound Interest Formula connects C.I., P, I and n. Where, three out of these four variables are given the fourth can be found out by simple calculations.

Illustration 8: Solving for Missing Variables

(a) **On what sum will the compound interest at 5% per annum for two years compounded annually be ₹ 1,640?**	(b) **What annual rate of interest compounded annually doubles an investment in 7 years? Given that $2^{1/7} = 1.104090$**
Solution: n = 2 ; i = 0.05 C.I. =P[$(1 + i)^n$ – 1] 1640 = P [$(1 + 0.05)^2$ – 1] 1640 = P (1.1025 – 1) P = 1,640 / 0.1025= 16,000 ∴ ₹ 16,000 is to be invested to earn Interest of ₹ 1,640, in 2 years time at 5% Compounded Annually.	**Solution:** If the Principal be P then A = 2P. A = P$(1 + i)^n$ 2P = P $(1 + i)^7$ ⇒ 2 = $(1 + i)^7$ Taking the 7th Root Both Sides , $2^{1/7} = (1 + i)$ 1.104090 = 1 + i i = 0.10409 ∴ Required Rate of Interest = 10.41% p.a.

(c) When will ₹ 8,000 amount to ₹ 8,820 at 10% per annum interest compounded half-yearly?

Solution:

m = 2, I = i/m = i/2 = .10/2 = 0.05 , N =mn = 2n (Reqd)

Principal (P)= ₹ 8,000

Amount (A)= ₹ 8,820

We know $A = P(1+I)^N$

$8,820 = 8,000(1+0.05)^N$

$\frac{8820}{8000} = (1.05)^N$

$1.1025 = (1.05)^N$

$(1.05)^2 = (1.05)^N$

N = 2

N = 2 = 2n, n =1, ∴ Number of Years = 1.

(d) Find the rate percent per annum if ₹ 2,00,000 amount to ₹ 2,31,525 in 1 ½ year interest being compounded half-yearly.

Solution:

Here P = ₹ 2,00,000

Amount (A) = ₹ 2,31,525

m = 2,

N = no. of conversion periods = mn= 1 ½ x 2 = 3

I = i/m = i / 2.

We know that,

$A = P(1 + I)^N$

$2,31,525 = 2,00,000(1 + I)^3$

$\frac{2,31,525}{2,00,000} = (1 + I)^3$

$1.157625 = (1 + I)^3$

$(1.05)^3 = (1 + I)^3$

I = 0.05 ; I = i/2 = 0.05, i =0.10 or 10% p.a.

Illustration 9: Solving for Missing Variables

A certain sum invested at 4% per annum compounded semi-annually amounts to ₹ 78030 at the end of one year. Find the sum.

Solution:

Here A = 78030

m=2, N = mn = 2 x 1 = 2, I = i/m = i/2 = 0.04 / 2 = 0.02

We have,

$A = P(1 + I)^N$

$A = P(1 + 0.02)^2$

$78030 = P(1.02)^2$

$P = 78030 / 1.02^2 =$ **75000**

Thus ₹ 75,000 is to be invested at 4% p.a. compounded semi annually to get an amount of ₹ 78,030 at the end of 1 year.

₹ 16000 invested at 10% p.a. Compounded Semi-Annually amounts to ₹ 18,522. Find the time period of investment.

Solution:

Here P = ₹ 16,000 , m = 2 , A = ₹ 18,522

m = 2 , I = i/m = 10 x ½ % = 5% = 0.05

N =mn = 2n **(Required)**

We have $A = P(1 + I)^N$

$18,522 = 16,000(1 + 0.05)^N$

$18,522 / 16,000 = (1.05)^N$

$(1.157625) = (1.05)^N$

$(1.05)^3 = (1.05)^N$

N = 3, N =2n = 3, **n = 1.5 years.**

∴ Required no. of years = 1.5 years.

Illustration 10: Solving for Missing Variables

A person opened an account on April, 2017 with a deposit of ₹ 800. The account paid 6% interest compounded quarterly. On October 1 2017 he closed the account and added enough additional money to invest in a 6 months time-deposit for ₹1000, earning 6% p.a. compounded monthly.

(a) How much additional amount did the person invest on October 1?

(b) What will be the maturity value of his deposit on April 1 2018?

(c) How much total interest is earned?

Given that $(1 + i)^n$ is 1.03022500 for i = 1 ½ %, n = 2 and $(1 + i)^n$ is 1.03037751 for i = ½ % and n = 6.

Solution:

(a) The Amount Received from the Initial Deposit of ₹ 800 for 6% Compounded Quarterly.

Given: P = 800, m = 4, I = i/4 = 0.06 / 4 = 0.015, N=mn = 4 × 0.5 = 2,

Reqd: Amount Earned at the End of the Closure Period of 6 Months – A.

$A = P(1 + I)^N$

$A = 800(1 + 0.015)^2 = 824.18$

∴Additional Amount Invested to Reach the Required principal of ₹ 1,000 = 1,000 – 824.18 = 175.82

(b) Amount from ₹ 1,000 time deposit.

Given: P = 1,000, m = 12, I = i/12 = 0.06 / 12 = 0.005, N=mn = 12 × 0.5 = 6,

Reqd: Amount Earned at the End of the Closure Period of 6 Months – A.

$A = P(1 + I)^N$

$A = 1,000(1 + 0.005)^6$

$A = 1,000(1.0304)$

$A = 1,030.40$

Total Interest Earned = ₹ 24.18 + 30.40 = ₹ 54.58

4.3 EFFECTIVE INTEREST RATE

Illustration 11: Effective Interest Rate

Ascertain the Effective Rate of Interest in the following situations –

1. **The Total Interest Paid during the Period = ₹ 100, the Amount Received at the End of the Period = ₹ 1,100.**
2. **The Interest Rate is 10%p.a compounded annually, The Opening Principal = ₹ 100. Find the Effective Interest Rate.**

Solution:

1. Effective Interest Rate = $\frac{\text{Total Interest during the year}}{\text{Opening Principal}}$

   Effective Interest Rate = $\frac{100}{1{,}100 - 100} = \frac{100}{1{,}000} = 10\%$ p.a.

2. (a) Total Interest During the Year under Compound Interest = $P[(1+i)^n - 1] = 100[(1+0.10)^1 - 1] = ₹\ 10$

   (b) Opening Principal = ₹ 100

   (c) Effective Interest Rate = $\frac{\text{Total Interest during the year}}{\text{Opening Principal}} = \frac{10}{100} = 0.10$ or 10% p.a.

Note: The Effective Interest Rate = Actual Interest Rate where the Interest is Compounded only once during a year.

Illustration 12: Effective Interest Rate

₹ 5000 is invested in a Term Deposit Scheme that fetches interest 6% per annum compounded quarterly. What will be the interest after one year? What is the Effective Rate of Interest?

Solution:

We know that under Compound Interest, the Total Interest during a given period is –

Interest = $P[(1 + I)^N - 1]$

$P = ₹\ 5000$ $\quad m = 4$ $\quad I = i/m = 0.06 / 4 = 0.15$ $\quad N = mn = 4n = 4 \times 1 = 4$

Interest $= ₹\ 5000\ [(1 + 0.015)^4 - 1]$
$= ₹\ 5000 \times 0.06136355$
$= ₹\ 306.82$

Effective Interest Rate = $\frac{\text{Total Interest during the year}}{\text{Opening Principal}} = \frac{306.82}{5{,}000} = 0.061364 = 6.1364\%$ p.a.

Alternatively, **Effective Interest Rate = $E = (1 + i/m)^m - 1$** $= (1 + 0.06/4)^4 - 1 = 1.06136 - 1 = 0.06136 = 6.136\%$ p.a.

Illustration 13: Effective Interest Rate – Application

Answer the Following –

Find the amount of compound interest and effective rate of interest if an amount of ₹ 20,000 is deposited in a bank for one year at the rate of 8% per annum compounded semi annually.

Solution:

We know that under Compound Interest,
Total Interest during a period = $P[(1 + I)^N - 1]$
$P = ₹\ 20{,}000$
$m = 2$
$I = i/m = i/2 = 0.08 / 2 = 0.04$
$N = mn = 2 \times 1 = 2$

$I = ₹\ 20{,}000\ [(1 + 0.04)^2 - 1]$
$= ₹\ 20{,}000 \times 0.0816$
$= ₹\ 1{,}632$

Effective rate of interest(E) $= [(1 + i/m)^m - 1]$
$= [(1 + 0.04)^2 - 1]$
$= 0.0816 = 8.16\%$

Also, the Actual Interest During One Year may also be Calculated as follows –

The Actual Interest during One Year = Opening Principal × 1 × Effective Interest Rate $= 20{,}000 \times 8.16\% \times 1 = ₹\ 1{,}632$

Which is a better investment 3% per year compounded monthly or 3.2% per year simple interest? Given that $(1 + 0.0025)^{12} = 1.0304$.

Solution:

1. Under Simple Interest Effective Interest Rate = Actual Interest Rate = 3.2% **[Since there is no question of Compounding in Simple Interest]**

2. Under Compound Interest,
Effective Interest Rate = $E = (1 + i/m)^m - 1$
$m = 12$
$I = i/m = .03/12 = 0.0025$
Effective Interest Rate = $E = (1 + i/m)^m - 1$
$= (1 + 0.0025)^{12} - 1$
$= 1.0304 - 1 = 0.0304 = 3.04\%$

Since the Effective Interest Rate is higher under the Compound Interest Scheme, the same may be preferred.

Note: Students may verify the answer by Comparing the Actual Interest paid during the First Year using Notional Principal.

4.4 TIME VALUE OF MONEY AND ANNUITY

Illustration 14: Future Value and Present Value of Money
Answer the Following Questions –

You invest ₹ 3,000 in a two year investment that pays you 12% per annum. Calculate the Future Value of the investment.

Solution:

Future Value of an investment is the Amount that will be received from an investment at the end of N years.

Future Value of Investment = F = C.F. $(1 + i)^n$

C.F. = Cash Flow = ₹ 3,000

i = rate of interest = 0.12

n = time period = 2

F = ₹ 3,000$(1 + 0.12)^2$

= ₹ 3,000 x 1.2544 = ₹ **3,763.20**

Find the Future Value of an Annuity of ₹ 500 made annually for 7 years at interest rate of 14% compounded annually. Given that $(1.14)^7 = 2.5023$.

Solution:

Here Annual Payment = P = ₹ 500

n = 7 ; i = 14% = 0.14

Future value of the annuity = P(7, 0.14) = $= \frac{P}{i}[(1+i)^n - 1]$

$= \frac{500}{0.14} \times [(1 + 0.14)^7 - 1] = \frac{500 \times (2.5023 - 1)}{0.14}$ = ₹ 5,365.36

₹ 200 is invested at the end of each of each month in an account paying interest 6% per year compounded monthly. What is the future value of this annuity after 10th payment? Given that $(1.005)^{10} = 1.0511$

Solution:

Regular payment = P = ₹ 200

Total No. of Payment = N = 10

I = i/m = 0.06/12 = 0.005

$P(n, i) = \frac{P}{I} \times [(1 + I)^N - 1]$

$P(10, 0.0050) = \frac{200}{0.005}[(1 + 0.005)^{10} - 1]$

$= \frac{200}{0.005}[(1.0511 - 1] = 40,000 \times 0.0511$

= ₹ **2,044**

Z invests ₹ 10,000 every year starting from today for next 10 years. Suppose interest rate is 8% per annum compounded annually, calculate Future Value of the Annuity. Given that $(1 + 0.018)^{10} = 2.15892500$.

Solution:

The Given problem is an "Annuity Immediate" problem, i.e the regular cash payments are made at the Beginning of the year.

Step 1:

Future Value of the Annuity Immediate = $\frac{P}{i}[(1 + i)^n - 1](1+i)$

$= \frac{10,000}{0.08}[(1 + 0.08)^{10} - 1](1.08)$

= 1,25,000 × 1.1589 × 1.08 = ₹ **1,56,451.50**

Illustration 15: Future Value and Present Value of Money
Answer the Following Questions –

What is the present value of ₹ 1 to be received after two years compounded annually at 10% interest rate?

Solution:

Present Value is the Amount to be invested now to get a specified amount at the end of the period.

Required Amount = A = ₹ 1

i = 10% = 0.1 , n = 2

We know that, $A = P(1+i)^n$, therefore $P = A / (1+i)^n$

Required present value (P) = $\frac{A}{(1+i)^n} = \frac{1}{(1+0.1)^2}$

= 1/ 1.21= 0.8264 = ₹ 0.83

Conclusion: ₹ 0.83 is required to be invested now to obtain ₹ 1 after 2 years at 10% interest rate compounded annually.

Find the present value of ₹ 10,000 to be required after 5 years if the interest rate be 9%. Given that $(1.09)^5 = 1.5386$.

Solution:

Here i = 0.09

n = 5

A = 10,000

Required Present Value(P) = $\frac{A}{(1+i)^n} = \frac{10000}{(1+0.09)^5}$

$= \frac{10,000}{1.5386}$ = ₹ 6,499.42

What is the Present Value of an Annuity consisting of payments of ₹ 10,000 at 10% compounded annually, paid for 10 years?

Solution:

Step 1: Ascertain the Future Value of the Annuity

Future Value of An annuity = $\frac{P}{i}[(1+i)^n - 1]$ where P=Regular Payments=10,000, i=0.10, n = 10 years.

$= \frac{10,000}{0.1}[(1+0.1)^{10}] = 1,00,000 \times 1.5937 = ₹\ 1,59,370.$

Step 2: Ascertain the Present Value of the Annuity

The Present Value of the Annuity and the Future Value of the Annuity are related through the following formula –

Present Value of the Annuity = $\frac{\text{Future Value of an annuity}}{(1+i)^n} = 1,59,370 / (1+0.1)^{10} = ₹\ \mathbf{61,445.04}$

Illustration 16: Applications of Annuity Formula

S borrows ₹ 5,00,000 to buy a house. If he pays equal instalments for 20 years and 10% interest on outstanding balance what will be the Equal Annual Instalment?

Solution:

Loan Amount = ₹ 500000 ; n = 20 ; i = 10% p.a. = 0.10

Step 1: Calculate the Future Value of the Loan Amount.

F.V. = A = P $(1+i)^n$ $= 5,00,000(1.1)^{20}$

$= 5,00,000\ (6.7275)$

$= 33,63,750$

Step 2: Calculate the Annual Payments equal to the Required Future Value of the Loan

Future Value of An annuity = $\frac{P}{I}[(1+i)^n - 1]$

$33,63,750 = \frac{P}{0.1}[(1+0.1)^{20} - 1]$

$3,36,375 = P\ [5.7275]$

$P = 3,36,375 / 5.7275 = ₹\ \mathbf{58,729.8123}$

₹ 5,000 is paid every year for ten years to pay off a loan. What is the loan amount if interest rate be 14% per annum compounded annually?

Solution:

P = ₹ 5,000 n = 10 i = 0.14

Step 1: Calculate the Future Value of the Loan Amount =

F.V. of Annuity = $\frac{P}{i}[(1+i)^n - 1]$

$= \frac{5,000}{0.14}[(1+0.14)^{10} - 1]$

$= 35,714.2857 \times 2.7072 = ₹\ \mathbf{96,685.7142}$

Step 2: Calculate the Present Value of the Loan Amount

P = A / $(1+i)^n$ $= 96,685.7142 / (1.14)^{10}$

$= \mathbf{26,080.5228}$

Hence the Loan amount presently disbursed is ₹ 26,080.5228, for a ten annual repayments of ₹ 5,000 at 14% p.a.

Y bought a TV costing ₹ 13,000 by making a down payment of ₹ 3,000 and agreeing to make equal annual payment for four years. How much would be each payment if the interest on unpaid amount be 14% compounded annually?

Solution: Here the Loan Amount is ₹ 10,000 i.e. ₹ 13,000 – ₹ 3,000 and we have to calculate Equal Annual Payment over the period of Four Years.

Given: Loan Amount = ₹ 10,000;n = 4; i=14% p.a. = 0.14

Required: Regular Payments (P)

Step 1: Calculate the Future Value of the Loan Amount.

F.V. = A = P $(1+i)^n$ $= 10,000(1.14)^4$

$= 10,000\ (1.6890)$

$= ₹\ \mathbf{16,890}$

Step 2: Calculate the Annual Payments equal to the Required Future Value of the Loan

F.V. Annuity $= \frac{P}{i}[(1+i)^n - 1]$

$16890 = \frac{P}{0.14}[(1+0.14)^4 - 1]$

$2364.60 = P\ [0.6890]$

$P = 2364.60 / 0.6890 = ₹\ \mathbf{3,431.9303}$

Suppose your mom decides to gift you ₹ 10,000 every year starting from today for the next five years. You deposit this amount in a bank as and when you receive and get 10% per annum interest rate compounded annually. What is the Present Value of this annuity?

Solution:

Since the Payments are starting today, it is an annuity immediate.

Step 1: Calculate the F.V. of Annuity Immediate

Future Value of the Annuity Immediate

$= \frac{10,000}{0.10}[(1+0.1)^5 - 1](1+0.1)$

$= 1,00,000\ [0.61051](1.1)$

$= 67,156.10$

Step 2: Present Value of the Annuity Immediate = F.V. of Annuity Immediate / $(1+i)^n$

Present Value of the Annuity Immediate = $67,156.10 / (1.1)^5$

$= 67,156.10 / 1.6105 = ₹\ \mathbf{41,698.9134}$

Illustration 17: Leasing Decisions

ABC Ltd. wants to lease out an asset costing ₹ 3,60,000 for a five year period. It has fixed a rental of ₹ 1,05,000 per annum payable annually starting from the end of first year. Suppose rate of interest is 14% per annum compounded annually on which money can be invested by the company. Is this agreement favourable to the company? Given: P(5, 0.14) = 3.43308

Solution:

A. Present Value of the Rental Income = Present Value of the Annuity of ₹ 1 @ 14% for 5 years × 1,05,000
= P(5,0.14) × 1,05,000
= 3.43308 × 1,05,000 = ₹ **3,60,473.40.**

B. Cost of the Asset = ₹ **3,60,000.**

C. Net Benefit = **473.40.**

D. Since the Net Benefit is positive the Asset may be leased out at the given parameters.

Note: The Present Value of an Annuity of ₹ 1 for n years can be obtained from the Table given in **Pg. No. T.2**

Illustration 18: Leasing Decisions

A company is considering proposal of purchasing a machine either by making full payment of ₹ 4000 or by leasing it for 4 years at an annual rental of ₹ 1250. Which course of action is preferable if the company can borrow at 14% Compounded Annually?

Solution:

1. The present value of an Annuity = Present Value of ₹ 1 for 4 years at 14% × 1250
= 1250 × P (4, 0.14)
= 1250 × 2.91371
= ₹ 3,642.14

∴ **The Present Value of the Lease Payments = ₹ 3,642.14.**

2. The Cost of the Machine if payment is made outright = ₹ **4,000.**

3. **Conclusion:** Since the Present Value of the Lease Payments is lower, the Company may to buy the Machine on Lease. The same will result in a savings of ₹ 357.86.

Illustration 19: Capital Investment Decisions

A machine can be purchased for ₹ 50,000. Machine will contribute ₹ 12,000 per year for the next five years. Assume borrowing cost is 10% per annum compounded annually. Determine whether machine should be purchased or not.

Solution:

1. The Present Value of Annual Benefit = A × P (n, i)
= 12,000 x P(5, 0.10)
= 12,000 x 3.79079
= ₹ 45,489.48

2. Initial Cost = ₹ 50,000

3. Net Loss = ₹ 4,510.52. Hence the Machine must not be purchased.

Illustration 20: Effective Savings – Investment Decisions

A machine with useful life of seven years costs ₹ 10,000 while another machine with useful life of five years costs ₹ 8,000. The first machine saves labour expenses of ₹ 1,900 annually and the second saves labour expenses of ₹ 2,200 annually. Determine the preferred course of action. Assume cost of borrowing as 10% compounded per annum.

Solution:

The present value of annual cost savings for the first machine = ₹ 1,900 x P (7, 0.10) = ₹ 1,900 x 4.86842 = ₹ 9249.99 = ₹ 9250 Cost of machine being ₹ 10,000 it costs more by ₹ 750 than it saves in terms of labour cost.	The present value of annual cost savings of the second machine = ₹ 2,200 x P(5, 0.10) = ₹ 2,200 x 3.79079 = ₹ 8,339.74 Cost of the second machine being ₹ 8000 effective savings in labour cost is ₹ 339.74. Hence the second machine is preferable.

Illustration 21: Bond Valuation

An investor intends purchasing a three year ₹ 1,000 par value bond having nominal interest rate of 10%. At which price the bond may be purchased now if it matures at par and the investor requires a rate of return of 14%?

Solution:

$$\text{Present values of the bond} = \frac{100}{(1+0.14)^1} + \frac{100}{(1+0.14)^2} + \frac{100}{(1+0.14)^3} + \frac{1000}{(1+0.14)^3}$$

$$= [100 \times 0.87719] + [100 \times 0.769467] + [100 \times 0.674\,972] + [1{,}000 \times 0.674972]$$

$$= 87.719 + 76.947 + 67.497 + 674.972 = ₹\ \mathbf{907.125}$$

Thus the Purchase Value of the bond is ₹ 907.125. This represents the Maximum Value for which the Bond may be purchased.

Illustration 22: Bond Valuation

A is willing to purchase a five years ₹ 1,000 Par Value Bond having a Coupon Rate of 9%. A's Required Rate of Return is 10%. How much A should pay to purchase the Bond, if it matures at par?

Solution: **Note:** Discounting should be done at the Required Rate of Return, i.e. Desired Yield = 10% in this case.

Nature	Period	Cash Flow	DF at 10% for 5 Periods	DCF
Interest (1,000 × 9%)	1 – 5	90	PVIFA = 3.791	341.19
Maturity Amount	5	1,000	PVIF = 0.621	621.00
Intrinsic Value				**₹ 962.19**

Illustration 23: Bond Valuation– Half yearly payment

A 6 years Bond of ₹ 1,000 has an annual rate of interest of 14 %. The interest is paid half yearly. If the Required Rate of Return is 16 %, what is the Value of the Bond?

Nature	Period	Cash Flow	DF at 8% for 12 Periods	DCF
Half Yearly Interest (1,000 × 14% × 6/12)	1 – 12	70	PVIFA = 7.536	527.52
Maturity Amount	12	1,000	PVIF = 0.397	397.00
Intrinsic Value				**₹ 924.52**

Note: Since Interest is payable half yearly, Present Value at the end of 6th Year is to be computed based on the half–yearly interest rate of 8%, and the number of periods as 12.

Illustration 24: Bond Valuation– Half yearly payment

Calculate Market Price of —

1. **10% Government of India Security currently quoted at ₹ 110, but Interest Rate is expected to go up by 1%.**
2. **A Bond with 7.5% Coupon Interest, Face Value ₹ 10,000 and term to maturity of 2 years, presently yielding 6% interest payable half–yearly.**

Solution: **1. 10% Government of India Bonds:**

(a) Current Yield $= \frac{\text{Interest Amount}}{\text{Current Market Price}} = \frac{10\% \times ₹100}{₹110} = \frac{₹10}{₹110} = 9.09\%$

Note: It is assumed that the Face Value is ₹ 100, and the Bond has a perpetual life.

(b) Revised Yield = 9.09% + 1% = 10.09%

(c) Revised Market Price $= \frac{\text{Interest Amount } ₹10}{\text{Market Yield } 10.09\%} = ₹\ \mathbf{99.10}$

2. 7.5% Bond

Nature	Period	Cash Flow	DF at 3% for 4 Periods	DCF
Half Yearly Interest (10,000 × 7.50% × 6/12)	1 – 4	375	PVIFA = 3.717	1,393.88
Maturity Amount	4	10,000	PVIF = 0.888	8,880.00
Market Price				**₹10,273.88**

Illustration 25: Bond Valuation– Different Yield Rates

10% Government of India Bonds (Annual Interest Payment) have five years to maturity and a Maturity Value of ₹ 10,000. Ascertain the value of the Bond today if the desired yields on such Bonds are 8%, 10% and 12%. Assuming the Desired Yield is 8%, and presently the Bond is traded at ₹ 11,500, what would you do?

Solution:

Yr	Nature	CF	Yield @ 8%		Yield @ 10%		Yield @ 12%	
			PVF @ 8%	DCF	PVF @ 10%	DCF	PVF @ 12%	DCF
1–5	Interest (10% × 10,000)	1,000	3.993	3,993	3.791	3,791	3.605	3,605
5	Maturity Value	10,000	0.681	6,810	0.621	6,210	0.567	5,670
	Value of Bond today			**10,803**		**10,001**		**9,275**

Action on Bond: If the Bond is traded at ₹ 11,500 now, its Current Market Price is greater than (Theoretical Value = Expected Price) at 8%, i.e. ₹ 10,803. This means that the Bond is overpriced. Hence, the Investor should **SELL** the Bond.

Illustration 26: Compounded Annual Growth Rate

The following data relating to Investment made by a Company for the past 5 years.

Years	1	2	3	4	5
Closing Market Price (₹)	50.00	64.00	85.00	100.00	125.00
Dividend Yield (₹)	4.00	8.00	10.00	15.00	15.00

Opening Market Price in Year 1 was ₹ 40. Also ascertain the Compounded Annual Growth Rate. What would be the Annual Growth Rate if there were no Dividend Payouts at all?

Solution:

Computation of Compounded Annual Growth Rate

$$\text{CAGR} = \sqrt[n]{\frac{\text{Total Return} + \text{Initial Investment}}{\text{Initial Investment}}} - 1 \text{ [Inverse of Compound Interest Formula]}$$

$$\text{OR} = \left[\frac{\text{Total Return} + \text{Initial Investment}}{\text{Initial Investment}}\right]^{1/n} - 1$$

where, "n" represents the period of holding.

(a) CAGR with Dividend Payouts:

$$= \sqrt[n]{\frac{\text{Total Return} + \text{Initial Investment}}{\text{Initial Investment}}} - 1$$

$$= \left[\frac{137 + 40}{40}\right]^{1/5} - 1 = (4.425^{1/5} - 1)$$

$= 1.3464 - 1 = 0.3464$ or **34.64%**

(b) CAGR without Dividend Payouts:

$$= \sqrt[n]{\frac{\text{Capital Appreciation Return} + \text{Initial Investment}}{\text{Initial Investment}}}$$

$$= \left[\frac{85 + 40}{40}\right]^{1/5} - 1 = (3.125^{1/5} - 1)$$

$= 1.2559 - 1 = 0.2559$ or **25.59%**

Illustration 27: Real vs Nominal Cash Flows – Discount Rate

Following are the expected Nominal Cash Flows of Project A, requiring an initial outlay of ₹ 1,00,000.

Year	1	2	3	4
Cash Flow	₹ 30,000	₹ 60,000	₹ 40,000	₹ 10,000

If the Cost of Capital of the Company in a static economy is 8%, and Inflation Rate is 5%, what is the appropriate Discount Rate for the Project? Should the Project be accepted?

Solution:

1.Determination of Discount Rate

Since cash–flows are expressed in Nominal Terms (after including the impact of inflation), the discount rate chosen should also be Nominal Discount Rate, i.e. Real Discount Rate adjusted for inflation.

Hence, $(1 + R_N) = (1 + R_R) \times (1 + I)$

Where, R_N = Nominal Discount Rate

R_R = Real Discount Rate (Without effects of inflation)

I = Inflation Rate

$(1 + R_N) = (1 + 8\%) \times (1 + 5\%)$

$= 1.08 \times 1.05 = 1.134$

$R_N = 1.134 - 1 = 0.134$ or 13.4%

Therefore, appropriate Discount Rate is 13.40% for evaluating the project.

2. Evaluation of Project

Particulars	Year	Disc. Factor @ 13.4%	Cash Flow	DCF
Annual Operating Cash Inflow	1	0.882	30,000	26,460
	2	0.777	60,000	46,620
	3	0.686	40,000	27,440
	4	0.605	10,000	6,050
Total Present Value of Cash Inflows				**1,06,570**
Less: Initial Investment	0	1.000	1,00,000	(1,00,000)
Net Present Value				**6,570**

The Project may be accepted since Net Present Value is positive.

4.5 PERPETUITY

Illustration 28: PV of a Constant Perpetuity

Ramesh wants to retire and receive ₹ 3,000 a month. He wants to pass this monthly payment to future generations after his death. He can earn an interest of 8% compounded annually. How much will he need to set aside to achieve his perpetuity goal?

PV of a **Constant** Perpetuity $= \frac{C}{R}$

Where **C** = ₹ 3,000
R = 0.08/12 or 0.00667

Substituting these values in the above formula, we get PV $= \frac{3,000}{0.00667} =$ **₹ 4,49,775**

Note: If Ramesh wants that the receipts of ₹ 3,000 should start from **today**, he must increase the size of the funds to handle the first payment, i.e. ₹ 4,52,775 which provides the immediate payment of ₹ 3,000 and leaves the balance ₹ 4,49,775 in the Fund to provide the future ₹ 3,000 payments.

Illustration 29: PV of a Growing Perpetuity

Assuming that the discount rate is 7% per annum, how much would you pay to receive ₹ 50, growing at 5%, annually forever?

Solution: PV of a **Growing** Perpetuity $= \frac{C}{R-G}$ Where **C** = ₹ 50, **R** = 0.07, and **G** = 0.05

Substituting these values in the above formula, we have PV $= \frac{50}{0.07-0.05} =$ **₹ 2,500**

Illustration 30: Present Value of a Perpetuity

(a) A Company has issued 12% Preference Share Capital with a Face Value of ₹ 100. What would be Market Price of the Preference Shares if the rate of interest for the investor is 10%?

(b) A Company has paid Equity Dividend of ₹ 10 per share. Its profits and dividends are expected to grow at 5%. Calculate the Market Price of the Equity Shares, if the rate of interest for the investor is 24%

(a) Market Value of Preference Shares = PV of a **Constant** Perpetuity $= \frac{C}{R} = \frac{₹\ 12}{10\%} =$ **₹ 120**

Note: This means that the Investor will be ready to pay ₹ 120 to purchase a Preference Share and earn a dividend of 12% on its Face Value.

(b) Market Price of Equity Shares = PV of a **Growing** Perpetuity $= \frac{C}{R-G} = \frac{₹\ 10}{24\%-5\%} = \frac{₹\ 10}{19\%} =$ **₹ 52.63**

Multiple Choice Questions

4.1 SIMPLE INTEREST

Note: Solve all the questions in this Part based on Simple Interest.

1. The amount charged for a defined length of time for use of the principal, generally on a yearly basis is known as –
   (a) Balance
   (b) Rate of interest
   (c) Principal
   (d) Interest

2. The principal remains constant for the whole loan period in –
   (a) simple interest
   (b) compound interest
   (c) effective interest
   (d) Annuity

3. Interest computed on the principal for the entire period of borrowing is called –
   (a) Simple Interest
   (b) Compound Interest
   (c) Balance
   (d) All of the above

4. Simple Interest on ₹3,500 for 3 years at 12% p.a. is
   (a) ₹1,200
   (b) ₹1,260
   (c) ₹2,260
   (d) None of these

5. P= 5000 R = 15 T = 4 ½ using I = PRT/ 100. I will be
   (a) ₹3,375
   (b) ₹3,300
   (c) ₹3,735
   (d) None of these

6. Find simple interest on ₹1,025 at 7½% p.a. for 4½ years.
   (a) ₹405.59
   (b) ₹375.45
   (c) ₹345.94
   (d) ₹354.94

7. The simple interest on ₹1,500 for 6 years at 5 % p.a. is –
   (a) ₹400
   (b) ₹300
   (c) ₹450
   (d) ₹500

8. The sum required to earn a monthly interest of ₹1,200 at 18% p.a. Simple Interest is –
   (a) ₹50,000
   (b) ₹60,000
   (c) ₹80,000
   (d) None of these

9. What will be the final value of investment for the principal value of ₹ 80,000 for 4 years @ 10% p.a. rate of interest?
   (a) ₹83,200
   (b) ₹ 1,12,000
   (c) ₹82,300
   (d) None of these.

10. A = ₹5,200 R = 5% p.a. T = 6 years P(S.I) will be –
    (a) ₹2,000
    (b) ₹4,000
    (c) ₹3,000
    (d) None of these

11. Sachin deposited ₹1,00,000 in his bank for 2 years at simple interest of 6%. How much interest would he earn? How much would be the final value of deposit?
    (a) ₹6,000, ₹1,06,000
    (b) ₹15,000, ₹1,15,000
    (c) ₹11,600,₹1,11,600
    (d) ₹12,000, ₹1,12,000

12. If ₹1,600 amounts to ₹2,100 is 5 years at a certain rate of simple interest. If the rate of interest is increased by 1 % it would amount to how much?
    (a) ₹2,080
    (b) ₹2,050
    (c) ₹2,250
    (d) ₹2,180

13. P = ₹10,000 I= ₹2,500 R = 12 ½% Simple Interest. The number of years T will –
    (a) 1 ½ years
    (b) 2 years
    (c) 3 years
    (d) None of these

14. In what time will ₹ 85,000 amount to ₹1,57,675 at 4.5% p.a?
    (a) 20 years
    (b) 15 years
    (c) 22 years
    (d) 19 years

15. ₹3,52,000 will produce ₹ 28,600 interest in – years at 2.5% p.a. simple interest.
    (a) 2 years 2 months
    (b) 3 years 3 months
    (c) 4 years 4 months
    (d) 5 years 5 months

16. A sum of money doubles itself in 10 years. The number of years it would trebles itself is –
    (a) 25 years
    (b) 15 years
    (c) 20 years
    (d) None of these

17. A sum of money doubles itself in 25 years. The number of years it would trebles itself is –
    (a) 50 years.
    (b) 37.5 years.
    (c) 75 years.
    (d) None of these.

18. P = ₹12,000 A= ₹16,500 T= 2 ½ years. Interest rate will be –
    (a) 15%
    (b) 12%
    (c) 10%
    (d) None of these

19. A person borrowed ₹4,000 and after 6 months the amount paid was ₹4,050. Find the rate of interest.
    (a) 5%
    (b) 25%
    (c) 2.5%
    (d) 20%

20. ₹80,000 is invested to earn a monthly interest of ₹ 1,200 at the rate of — p.a. SI.
    (a) 12%
    (b) 14%
    (c) 16%
    (d) 18%

21. A Sum of ₹46,875 was lent out at simple interest and at the end of 1 yr and 8 months, the total amount was ₹50,000. Find the rate of interest.
    (a) 4%
    (b) 5%
    (c) 4.5%
    (d) 6%

22. A sum doubles itself in 10 years. Find interest rate.
    (a) 10 %
    (b) 12 %
    (c) 15 %
    (d) 20 %

23. If a sum triples in 15 yrs at Simple rate ofinterest then the rate of interest per annumwill be
    (a) 13.0%
    (b) 13.3%
    (c) 13.5%
    (d) 18%

24. If the interest on ₹2,400 be more than the interest on ₹2,000 by ₹64 in 4 years, rate of interest is –
    (a) 5 %
    (b) 4 %
    (c) 3 1/3 %
    (d) 6 %

25. A certain sum of money at simple interest amounts to ₹2,800 in 2 years and to ₹3,220 in 5 years. The rate of interest p.a. is –
    (a) 6 1/3 %
    (b) 5 5/9 %
    (c) 2 ¼ %
    (d) 6 1/8 %

26. Kapil deposited some amount in a bank for 7 ½ years at 6% SI. Kapil received ₹1,01,500 at the end of the term. Compute initial deposit of Kapil.
    (a) ₹ 1,00,000
    (b) ₹70,000
    (c) ₹75,000
    (d) ₹86,500

27. What sum of money will produce ₹28,600 interest in 3 yrs& 3 mths at 2.5% p.a. simple interest?
    (a) ₹3,52,000
    (b) ₹3,65,000
    (c) ₹3,25,000
    (d) ₹3,56,000

28. Find out the capital required to earn a monthly interest of ₹800 p.m. at 5 % at simple interest?
    (a) ₹1,87,000
    (b) ₹40,000
    (c) ₹1,28,000
    (d) ₹1,92,000

29. Interest on a certain sum of money 2 ½ years at 3 ¼ % p.a. is ₹390. The sum is –
    (a) ₹4,800
    (b) ₹2,100
    (c) ₹4,700
    (d) ₹4,900

30. A sum was put at simple interest, at a certain rate for 3 years. Had it been put at 1 % higher rate it would have fetched ₹63 more. The sum is –
    (a) ₹2,400
    (b) ₹2,200
    (c) ₹2,100
    (d) ₹2,480

31. A sum of money that will give ₹ 1, as interest per day at 10 % p.a. simple interest is –
    (a) ₹3,800
    (b) ₹3,000
    (c) ₹ 3,650
    (d) ₹3,500

32. A sum of money amounts to ₹795 in 4 years and ₹850 in 5 years. The sum is –
    (a) ₹3,800
    (b) ₹3,000
    (c) ₹3,650
    (d) ₹3,500

33. Two equal amounts of money are deposited in two different banks each at 12% p.a. for 8 years and 3.5 years respectively. If the difference between their interests is ₹540, find each sum.
    (a) ₹1,200
    (b) ₹1,000
    (c) ₹1,400
    (d) ₹1,350

34. A sum of money amount to ₹6,200 in 2 years and ₹7,400 in 3 years. The principal and rate of interest are:
(a) ₹3,800, 31.57%
(b) ₹3,000, 20%
(c) ₹3,500, 15%
(d) None of these

35. A sum of money amounts to ₹ 7,803 for one year at the rate of 4% compounded semiannually then the sum invested is
(a) 7,000
(b) 7,500
(c) 7,750
(d) 8,000

36. A sum of money kept in a bank amounts to ₹1,000 in 4 years and ₹1,400 in 12 years. The sum and interest carried every year are –
(a) $600,133\frac{1}{3}$
(b) 800,50
(c) 750,150
(d) 850,75

37. No. of years a sum 4 times itself at 12% pa at SI:
(a) 20
(b) 21
(c) 25
(d) 30

38. A sum of money will be doubled itself in 8 years at S.I. In how many years the sum will be tripled itself?
(a) 20 years
(b) 12 years
(c) 16 years
(d) None of these

39. A sum of 44,000 is divided into 3 parts such that the corresponding interest earned after 2 years, 3 years and 6 years may be equal at the rate of simple interest are 6% p.a., 8% p.a., & 6% p.a. respectively. Then the smallest part of the sum will be:
(a) ₹ 4,000
(b) ₹ 8,000
(c) ₹ 10,000
(d) ₹ 12,000

40. A bank pays 10% rate of interest, interest being calculated half yearly. A sum of ₹400 is deposited in the bank. The amount at the end of 1 years will be
(a) ₹439
(b) ₹440
(c) ₹442
(d) ₹441

41. A certain money doubles itself in 10 years when deposited on simple interest. It would triple itself in
(a) 30 years
(b) 20 years
(c) 25 years
(d) 15 years

42. A certain sum of money Q was deposited for 5 year and 4 months at 4.5% simple interest and amounted to ₹248, then the value of Q is
(a) ₹240
(b) ₹200
(c) ₹220
(d) ₹210

4.2 COMPOUND INTEREST

1. The difference between the final amount and the original principal is called the –
(a) simple interest
(b) compound interest
(c) effective interest
(d) annuity

2. In the formula A = P + I, A is known as –
(a) Simple interest
(b) Principal
(c) Balance
(d) Compound interest

3. The principal goes on changing every year in –
(a) simple interest
(b) compound interest
(c) effective interest
(d) All of the above

4. P= ₹1000 R = 5% p.a. n=4 ; Amount and CI are –
(a) ₹1,215, ₹215
(b) ₹1,125, ₹125
(c) ₹2,115, ₹115
(d) None of these

5. ₹10,000 is invested at annual rate of interest of 10%. Amount after two years at annual compounding is –
(a) ₹ 21,100
(b) ₹ 12,100
(c) ₹ 12,110
(d) None of these

6. ₹100 will become after 20 years at 5% p.a. compound interest calculated annually –
(a) ₹250
(b) ₹265
(c) ₹265.50
(d) None of these

7. ₹7,500 is invested at 5 % compound interest for 2 years. The interest for the second year is –

(a) ₹375
(b) ₹350
(c) ₹450
(d) ₹393.75

8. The C.I. on ₹16,000 for 1½ years at 10% p.a. payable half–yearly is –
(a) ₹2,222
(b) ₹2,522
(c) ₹2,500
(d) None of these

9. The compound interest on half–yearly rests on ₹10,000 the rate for the first and second years being 6% and for the third year 9% p.a is –
(a) ₹ 2,290
(b) ₹ 2,287
(c) ₹ 2,285
(d) ₹ 2,283

10. Determine the compound interest on ₹1,000 at 6% compounded semi–annually for 6 yrs. Given that $(1+i)^n = 1.42576$ for I = 3% and n = 12.
(a) ₹425.76
(b) ₹445.26
(c) ₹520.40
(d) ₹260.20

11. Compute the compound interest on ₹4,000 for 1 ½ years at 10% p.a. compounded half–yearly.
(a) ₹360.50
(b) ₹600
(c) ₹630.50
(d) ₹625

12. ₹2,000 is invested at annual rate of interest of 10% p.a. The amount after two years if compounding is done half yearly, is –
(a) ₹2431
(b) ₹243.10
(c) ₹2341
(d) None of these

13. The C.I. on ₹40,000 at 10% p.a. for 1 years when the interest is payable quarterly is –
(a) ₹4,000
(b) ₹4,100
(c) ₹4,152.51
(d) None of these

14. The C.I. on ₹4,000 for 6 months at 12% p.a. payable quarterly is –
(a) ₹243.60
(b) ₹240
(c) ₹243
(d) None of these

15. ₹ 3,000 is invested at annual rate of interest of 10% p.a. The amount after two years if compounding is done quarterly, is –
(a) ₹3,556.20
(b) ₹3,565
(c) ₹3,655.20
(d) None of these

16. The compound interest on ₹1,000 for 10 years at 4% p.a. the interest being paid quarterly is –
(a) ₹786
(b) ₹586
(c) ₹489
(d) ₹186

17. ₹ 4,000 is invested at annual rate of interest of 10% p.a. The amount after two years if compounding is done monthly, is –
(a) ₹4,881.16
(b) ₹4,818.16
(c) ₹4,888.16
(d) None of these

18. The Partners A& B together lent ₹ 3903 at 4% p.a interest compounded annually. After aspan of 7 years, A gets the same amount as Bgets after 9 years. Share of A in ₹ 3903/- would have been –
(a) ₹ 1875
(b) ₹ 2280
(c) ₹ 2028
(d) ₹ 2820

19. ₹2,000 is invested at 10% p.a. What is the amount after 2 yrs if compounding is done (a) Annually (b) Semi–Annually (c) Quarterly (d) Monthly.
(a) ₹2,430, ₹2,531, ₹2,638, ₹2,700
(b) ₹2,420, ₹2,431, ₹2,437, ₹2,441
(c) ₹2,130, ₹2,483, ₹2,643, ₹2,550
(d) ₹2,420, ₹2,431, ₹2,468, ₹2,712

20. If A = ₹1000 n = 2 years R = 6% p.a compound interest payable half–yearly then principal (P) is –
(a) ₹890
(b) ₹880
(c) ₹800
(d) None of these

21. If A = ₹10,000 n = 18 yrs R = 4% p.a C.I, P will be –
(a) ₹4,000
(b) ₹4,900
(c) ₹4,500
(d) None of these

22. On what sum will the compound interest at 5% p.a. for 2 yrs compounded annually be ₹1,640?
(a) ₹ 16,000
(b) ₹ 17,000
(c) ₹ 18,000
(d) ₹ 19,000

23. Compound interest on a certain sum for 2 years is ₹41.60 and the simple interest is ₹40. Find the sum.
(a) ₹500
(b) ₹400
(c) ₹250
(d) ₹300

24. The difference in simple interest and compound interest on a certain sum of money in 2 years at 15% p.a. is ₹144. The sum is –
(a) ₹6,000
(b) ₹6,200
(c) ₹6,300
(d) ₹6,400

25. The difference between the simple interest and compound interest on a certain sum of money invested for 2 years 5% p.a. is ₹ 30. Then the sum =
(a) 10,000
(b) 12,000
(c) 13,000
(d) None

26. The compound interest on a certain sum for 2 years is ₹41 and the simple interest is ₹40. Find the interest % p.a.
(a) 4 %
(b) 5 %
(c) 6 %
(d) 8 %

27. A sum of money put at compound interest amount to ₹2,205 in 2 years and to ₹2,315.25 in 3 years. Find the interest % p.a.
(a) 10 %
(b) 5 %
(c) 8 %
(d) 6 %

28. If the sum of money when compounded annually becomes ₹ 1,140 in 2 years and ₹ 1,710 in 3 years, the Rate of Interest is
(a) 30 %
(b) 40 %
(c) 50 %
(d) 60 %

29. At what rate % will a sum double itself in 7 years if the interest is compounded annually.
(a) 7.0%
(b) 8.0%
(c) 10.41%
(d) 7.9%

30. For a 10–year deposit, what interest rate payable annually is equivalent to 5% interest payable quarterly?
(a) 5.1%
(b) 4.9%
(c) 6.0%
(d) None of these

31. Find the rate, if ₹2,00,000 amount to ₹2,31,525 in 1½ year interest being compounded half–yearly.
(a) 15%
(b) 11%
(c) 8%
(d) 10%

32. A sum of money yields at compound interest ₹200 and ₹220 at the end of first and second year respectively. The rate % is –
(a) 20
(b) 15
(c) 10
(d) 5

33. What annual rate of interest compounded annually doubles an investment in 7 years?
[Given that $2^{1/7}$ =1.104090]
(a) 10.41%
(b) 11.50%
(c) 9.65%
(d) 10.26%

34. At what rate per cent compound interest does a sum of money becomes four fold in 2 years?
(a) 150 %
(b) 100 %
(c) 200 %
(d) 400 %

35. What is the annual rate of interest compounded annually which doubles an investment in 2 years. Given that $\sqrt{2}$ = 1.4142135.
(a) 46.04125 %
(b) 14.142135
(c) 41.42135 %
(d) None of these

36. In how many years will a sum of money double at 5% p.a. compound interest?
(a) 15 years 3 months
(b) 14 years 2 months
(c) 14 years 3 months
(d) 15 years 2 months

37. In how many years a sum of money treble at 5% p.a. compound interest payable on half–yearly rests?
(a) 18 years 7 months
(b) 18 years 6 months
(c) 18 years 8 months
(d) 22 years 3 months

38. In what time will ₹8,000 amount to ₹8820 at 5% p.a. interest compounded half–yearly?
(a) 3 years
(b) 2years 5 months
(c) 2 years
(d) 2 years 1 month

39. ₹16,000 invested at 10% p.a. compounded semi–annually amounts to ₹18,522. Find the time period of investment.
(a) 1 year
(b) 1 ½ years
(c) 2 years
(d) 1 ¾ years

40. In what time will compound interest on ₹320 at 12½% p.a. compounded annually be ₹85?
(a) 4½ Years
(b) 2½ Years
(c) 2 Years
(d) 5 Years

41. In what time will a sum of ₹800 at 5% p.a. compound interest amount to ₹882?
(a) 1 years
(b) 5 years
(c) 4 years
(d) 2 years

42. Find the least number of complete years in which the sum of money put out on at 20 % compound interest will be more than double.
(a) 1 year
(b) 2 years
(c) 3 years
(d) 4 years

43. The time by which a sum of money would treble itself at 8% p.a CI is –
(a) 14.28 years
(b) 14 years
(c) 12 years
(d) None of these

44. A sum of money at compound interest amounts to thrice itself in 3 years. In how many years will it be 9 times itself?
(a) 18
(b) 12
(c) 9
(d) 6

45. In how many years a sum will double at 10% p.a. compound interest?
(a) 8 years 3 months
(b) 7 years 2 months
(c) 7 years 6 months
(d) 8 years 2 months

46. A sum of money triples itself in 20 years. The number of years it would double itself. (C.I) –
(a) 13.2 years
(b) 15.2 years
(c) 10 years
(d) 12.6 years

47. The population of a town increases every year by 2% of the Population at the beginning of that year. The number of years by which the total increase of population be 40% is –
(a) 7 years
(b) 10 years
(c) 17 years (app)
(d) None of these

48. The annual birth and death rates per 1,000 are 39.4 and 19.4 respectively. The number of years in which the population will be doubled assuming there is no immigration or emigration is –
(a) 35 yrs
(b) 30 yrs
(c) 25 yrs
(d) None of these

49. Saina deposited ₹1,00,000 in a nationalized bank for three years. If the rate of interest is 7% p.a. compounded annually. Calculate the amount at the end of the third year.
(a) ₹1,23,000
(b) ₹1,22,504.30
(c) ₹1,20,550.20
(d) ₹1,35,256.40

50. The difference between the S.I. and the C.I. on ₹2,400 for 2 years at 5% p.a is –
(a) ₹5
(b) ₹10
(c) ₹16
(d) None of these

51. The difference between compound and simple interest at 5% p.a for 4 years on ₹20,000 is –
(a) ₹250
(b) ₹277
(c) ₹300
(d) ₹310

52. The difference between CI and SI on a certain sum for 2 years at 6% p.a. is ₹13.50. Find the sum.
(a) ₹3,750
(b) ₹2,750
(c) ₹4,750
(d) None of these

53. The difference between CI and SI on a certain sum of money for 2 years at 4% p.a. is ₹ 1. The sum is
(a) ₹ 625
(b) ₹ 630
(c) ₹ 640
(d) ₹ 635

54. The difference between SI and CI on a certain sum for 3 years at 5% p.a. is ₹76.25. Find the sum.
(a) ₹5,000
(b) ₹8,000
(c) ₹9,000
(d) ₹10,000

55. The compound interest on a certain sum of money for 2 years at 10 % p.a. is ₹420. find the simple interest at the same rate and for the same time.
(a) ₹400
(b) ₹350
(c) ₹380
(d) ₹375

56. Suppose your mom decides to gift you ₹ 10,000 every year starting from today for the next sixteen

years. You deposit this amount in a bank as and when you receive and get 8.5% per annum interest rate compounded annually. What is the present value of this money: Given that P (15, 0.085) = 8.304236
(a) 83042
(b) 90100
(c) 93042
(d) 10100

57. On a certain sum rate of interest @ 10% p.a., S.I=₹ 90 Term = 2 year, Find Compound interest for the same:
(a) 544.5
(b) 94.5
(c) 450
(d) 18

58. A certain sum of money double itself in 4 years at C.I. In how many years it will become 32 times to itself
(a) 16 years
(b) 24 years
(c) 20 years
(d) 12 years

59. The future value of an annuity of ₹ 1,000 made annually for 5 years at the rate of interest 14% compound annually is
(a) ₹ 5610
(b) ₹ 6610
(c) ₹ 6160
(d) ₹ 5160

60. If ₹10,000 is invested at 8% per year compound quarterly, then the value of the investment after 2 years is [given $(1+0.02)^8$–1.171659]
(a) ₹10,716.59
(b) ₹11,716.59
(c) ₹117.1659
(d) None of the above

61. A men deposited ₹8,000 in a bank for 3 years at 5% per annum compound interest, after 3 years he will get
(a) ₹9,000
(b) ₹8,800
(c) ₹9,200
(d) ₹9,261

62. If in two years time a principal of ₹100 amounts to ₹121 when the interest at the rate of r% is compounded annually, then the value of r will be
(a) 14
(b) 10.5
(c) 15
(d) 10

63. How much will ₹25,000 amount to in 2 years at compound interest if the rates for the successive years are 4% and 5% per year
(a) ₹27,000
(b) ₹27,300
(c) ₹27,500
(d) ₹27,900

64. ₹8,000/– at 10% per annum interest compounded half yearly will become at the end of one year
(a) ₹ 8,800/–
(b) ₹ 8,900/–
(c) ₹ 8820
(d) ₹ 9,600

65. If compound interest on a sum for 2 years at 4% per annum is ₹102, then the simple interest on the same period at the same rate will be
(a) ₹ 90
(b) ₹ 100
(c) ₹ 101
(d) ₹93

66. If the difference between the compound interest compounded annually and simple interest on a certain amount at 10% per annum for two years is ₹372, then the principal amount is
(a) ₹ 37,000
(b) ₹ 37,200
(c) ₹ 37,500
(d) None of the above

4.3 EFFECTIVE RATE OF INTEREST

1. The equivalent annual rate of interest due to compounding is –
(a) Effective rate of interest
(b) Simple interest
(c) Compound interest
(d) All of the above

2. The effective rate of interest corresponding to a nominal rate 3% p.a. payable half yearly in –
(a) 3.2% p.a.
(b) 3.25% p.a
(c) 3.0225 % p.a
(d) None of these

3. Effective rate of interest for 3% p.a. compounded monthly is – [Given that $(1+0.0025)^{12} = 1.0304$]
(a) 3%
(b) 3.02%
(c) 3.04%
(d) 3.01%

4. The effective rate if interest corresponding a nominal rate of 7% p.a. compounded quarterly is –
(a) 7%
(b) 7.5%
(c) 7.19%
(d) None of these

5. Find the effective rate of interest if I=₹1,800, P=18,000, t=1 year
   (a) 10%
   (b) 9%
   (c) 18%
   (d) None of these.

6. ₹5,000 is invested in a Term Deposit Scheme that fetches interest 6% p.a. compounded quarterly. What will be the interest after 1 year? What is effective rate of interest?
   (a) ₹300, 6%
   (b) ₹276.28, 5.83%
   (c) ₹ 306.82, 6.13%
   (d) ₹ 325, 6.31%

7. Find the compound interest and effective rate of interest if an amount of ₹20,000 is deposited in a bank for 1 year at the rate of 8% p.a. compounded semi–annually.
   (a) ₹ 1426, 7.56%
   (b) ₹1632, 8.16%
   (c) ₹1326, 7.35%
   (d) ₹1744, 8.55%

8. Ram is confused whether to invest at 9% p.a. compounded monthly or 9.25% p.a. SI. Given that $(1+0.0075)^{12} = 1.09380690$. He decided to find effective rate of interest which is –
   (a) 9%
   (b) 9.25%
   (c) 9.38%
   (d) None of these

9. The effective rate of interest for one year deposit corresponding to a nominal 7% rate of interest per annum convertible quarterly is
   (a) 7%
   (b) 7.4%
   (c) 7.5%
   (d) 7.18%

4.4 ANNUITY

Future Value

1. A sequence of periodic payments over a number of years is–
   (a) compound interest
   (b) annuity
   (c) effective interest
   (d) simple interest

2. Life Insurance Policy is an example of –
   (a) compound interest
   (b) annuity
   (c) effective interest
   (d) simple interest

3. In _____ first payment/receipt takes place at the end of first period.
   (a) Annuity immediate
   (b) Annuity regular
   (c) Annuity due
   (d) Annuity special

4. The amount of an annuity of ₹150 for 12 years at 3.5% p.a C.I is –
   (a) ₹2,190.28
   (b) ₹1,290.28
   (c) ₹2,180.28
   (d) None of these

5. If the amount of an annuity for 25 years at 5 % p.a. C.I. is ₹50,000 the annuity will be –
   (a) ₹1,406.90
   (b) ₹1,046.90
   (c) ₹1,146.90
   (d) None of these

6. A =₹100 N = 10 R = 5 I = R / 100 M = ? using the formula $M = a / I \{(1+i)^n - 1\}$
   (a) ₹1,258
   (b) ₹2,581
   (c) ₹1,528
   (d) None of these

7. Find the amount of annuity if payment of ₹7,000 is made annually for 7 years at interest rate of 6% compounded annually.
   (a) ₹48,756
   (b) ₹50,857
   (c) ₹50,363
   (d) ₹58,756

8. Given annuity of ₹100 amounts to ₹3,137.12 at 4.5% p.a. C.I. The number of years will be –
   (a) 25 years (appx.)
   (b) 20 years (appx)
   (c) 22 years
   (d) None of these

9. ₹200 is invested at the end of each month in an account paying interest 6% per year compounded monthly. What is the future value of this annuity after 10^{th} payment? Given that $(1.005)^{10} = 1.0511$.
   (a) ₹2,000
   (b) ₹2,050
   (c) ₹2,025
   (d) ₹2,044

10. A person invests ₹500 at the start of each year with a bank which pays interest at 10% p.a. C.I. annually. The amount standing to his credit one year

after he has made his yearly investment for the 12th time is –
(a) ₹11,761.35
(b) ₹10,000
(c) ₹12,000
(d) None of these

11. Z invests ₹10,000 every year starting from today for next 10 years. Suppose interest rate is 8% p.a. compounded annually. Calculate the future value of the annuity. Given that $(1+.08)^{10} = 2.15892500$.
(a) ₹1,50,580
(b) ₹1,56,454.875
(c) ₹1,58,652.22
(d) ₹1,56,902.36

12. Alibaba borrows ₹6 Lakhs Housing Loan at 6% repayable in 20 annual installments commencing at the end of the first year. How much annual payment is necessary?
(a) ₹52,420
(b) ₹52,419
(c) ₹52,310
(d) ₹52,320

13. If a person lends ₹ 6,000 for 4 years and ₹ 8,000 for 3 years at S.I. the total interest earned is ₹ 2,400 then the rate of interest is
(a) 5%
(b) 6%
(c) 7%
(d) 8%

14. If the value of a car gets depreciated by 20% p.a., estimated value at the end of five year, if its present value is ₹ 24,000 is –
(a) ₹7,864.32
(b) ₹7,684.23
(c) ₹87,64.32
(d) ₹6,789.32

15. Johnson left ₹1,00,000 with the direction that it should be divided in such a way that his minor sons Tom Dick and Harry aged 9, 12 and 15 years should each received equally after attaining the age 25 years. The rate of interest being 3.5% how much each son receive after getting 25 years old?
(a) ₹50,000
(b) ₹51,994
(c) ₹52,000
(d) None

16. Appu retires at 60 years receiving a pension of ₹14,400 a year paid in half-yearly installments for rest of his life after reckoning his life expectation to be 13 yrs and that interest at 4% p.a is payable half yearly. What single sum is equivalent to his pension?
(a) ₹1,45,000
(b) ₹1,44,900
(c) ₹1,44,800
(d) ₹1,44,700

Present Value

17. Present Value of ₹10,000 due in 2 years at 5% p.a. when interest is compounded on yearly basis is –
(a) ₹9,070
(b) ₹9,059
(c) ₹9,061
(d) ₹9,060

18. What is the present value of ₹ 1 to be received after 2 years compounded annually at 10%?
(a) ₹ 0.83
(b) ₹0.91
(c) ₹0.88
(d) ₹0.79

19. Find the present value of ₹10,000 to be required after 5 years if the interest rate be 9%. Given that $(1.09)^5 = 1.5386$.
(a) ₹6,499.42
(b) ₹7,459.33
(c) ₹6,544.50
(d) ₹6,994.62

20. A person invested money in bank paying 6% Compounded semi annually. If the person expects to receive ₹8,000 in 6 years, what is the present value of investment?
(a) ₹5,000
(b) ₹4,611.03
(c) ₹5,611.03
(d) None of these

21. A = ₹1,200 N = 12 yrs I=0.08 V = ? using the formula $v = A/I \{1-(1+i)^{-n}\}$
(a) ₹3,039
(b) ₹3,990
(c) ₹9,930
(d) None of these

22. The present value of an annuity of ₹3,000 for 15 years at 4.5% p.a C.I. is –
(a) ₹23,809.41
(b) ₹32,809.41
(c) ₹32,908.41
(d) None of these

23. A loan of ₹10,000 is to be paid backing 30 equal installments. The amount of each installation to cover the principal and at 4% p.a. CI is –
(a) ₹587.87
(b) ₹587
(c) ₹578.87
(d) None of these

24. The present value of annuity of ₹5,000 p.a. for 12 years at 4% p.a. C.I. annually is –
(a) ₹46,000
(b) ₹46,925
(c) ₹15,000
(d) None of these

25. The present value of an annuity of ₹80 a years for 20 years at 5% p.a is –
(a) ₹997 (appx)
(b) ₹900

(c) ₹1,000
(d) None of these

26. The present value of an annuity of ₹3,000 for 15 years at 4.5% p.a CI is –
(a) ₹ 23,809.41
(b) ₹ 32,809.41
(c) ₹ 32,908.41
(d) None of these.

27. Find the present value of an ordinary annuity of 8 quarterly payments of ₹500 each, the rate of interest being 8% p.a. compound quarterly.
(a) ₹4,292.50
(b) ₹4,725.00
(c) ₹3,662.50
(d) ₹3,266.50

28. A company borrows ₹10,000 on condition to repay it with compound interest at 5% p.a. by annual installments of ₹1,000 each. The number of years by which the debt will be clear is –
(a) 14.2 years
(b) 10 years
(c) 12 years
(d) None of these

29. Mr. Paul borrows ₹25,000 on condition to repaid it with C.I. at 7% p.a. in annual installments of ₹3,000 each. The number of years for the debt to the paid off is –
(a) 10 years
(b) 12 years
(c) 11 years
(d) 13 years

30. Suppose your mom decides to gift you ₹10,000 every year starting form today for the next 5 years. You deposit this amount in a bank as and when you receive and get 10% p.a. interest rate compounded annually. What is the present value of this annuity?
(a) ₹40,702.70
(b) ₹42,533.21
(c) ₹41,698.70
(d) ₹43,883.33

31. Raja aged 40 wished his wife Rani to have ₹40 Lakhs at his death. If his expectation of life is another 30 years and he starts making equal annual investments commencing now at 3% compound interest p.a. how much should he invest annually?
(a) ₹84,448
(b) ₹84,450
(c) ₹84,449
(d) ₹84,077

32. How much amount is required to be invested every year so as to accumulate ₹3,00,000 at the end of 10 years if interest is compounded annually at 10%?
(a) ₹18,222.63
(b) ₹18,823.62
(c) ₹18,725.52
(d) ₹18,955.06

33. A person desires to create a fund to be invested at 10% C I p.a. to provide for a prize of ₹300 every years. Using V = A /I find V and V will be
(a) ₹2,000
(b) ₹2,500
(c) ₹3,000
(d) None of these

34. What is the net present value of piece of property which would be valued at ₹2 lakh at the end of 2 years? (Annual rate of increase = 5%)
(a) ₹ 2.00 lakh
(b) ₹ 1.81 lakh
(c) 2.01 lakh
(d) None of the above

4.5 APPLICATIONS

1. A sinking fund is created for reducing debentures worth ₹5 Lakhs at the end of 25 years. How much provision needs to be made out of profits each year provided sinking fund investments can earn interest at 4% p.a?
(a) ₹12,006
(b) ₹12,040
(c) ₹12,039
(d) ₹12,035

2. A machine is depreciated the rate of 20% on reducing balance.The original cost of the machine was ₹1,00,000and its ultimate scrap value was ₹30,000. The effective life of the machine is –
(a) 4.5 years (appx)
(b) 5.4 years (appx)
(c) 5 years (appx.)
(d) None of these

3. A machine the useful life of which is estimated to be 10 years cost ₹10,000. Rate of depreciation is 10% p.a. The scrap value at the end of its life is –
(a) ₹3,483
(b) ₹4,383
(c) ₹3,400
(d) None of these

4. A machine worth ₹4,90,740 is depreciated at 15% of its opening value each year. When its value would reduce by 90%?
(a) 14 years 6 months
(b) 14 years 2 months
(c) 14 years 5 months
(d) None

5. A machine costs ₹5,20,000 with an estimated life of 25 years. A sinking fund is created to replace it by a new model at 25%m higher cost after 25 years with a scrap value realization of ₹25,000. What amount should set aside every year if the sinking fund investments accumulate at 3.5% compound interest p.a?
   (a) ₹16,000
   (b) ₹16,500
   (c) ₹16,050
   (d) ₹16,005

6. A machine for which the useful life is estimated to be 5 years cost ₹ 5,000. Rate of depreciation is 10% p.a. The scrap value at the end of its life is –
   (a) ₹2,952.45
   (b) ₹2,500.00
   (c) ₹3,000.00
   (d) ₹2,559.50

7. A machine depreciates at 10% of its value at the beginning of a year. The cost and scrap value realized at the time of sale being ₹23,240 and₹9,000 respectively for how many years the machine was put to use?
   (a) 7 years
   (b) 8 years
   (c) 9 years
   (d) 10 years

8. A machine worth ₹4,90,740 is depreciated at 15% of its opening value each year. When its value would reduce to ₹2,00,000?
   (a) 4 years 6 months
   (b) 5 years 7 months (approx.)
   (c) 4 years 5 months
   (d) None

9. A person bought a house paying ₹20,000 cash down and ₹4000 at the end of each years for 25 yrs. At 5% p.a C.I. The cash down price is –
   (a) ₹75,000
   (b) ₹76,000
   (c) ₹76,392
   (d) None of these

10. A man purchased a house valued at ₹3,00,000. He paid ₹2,00,000 at the time of purchase and agreed to pay the balance with interest at 12% p.a. compounded half yearly in 20 equal half yearly installments. If the first installment is paid after six months from the data of purchase then the amount of each installment is [Given Log10.6 = 1.0253 and log 31.19 = 1.494]
    (a) ₹8,719.66
    (b) ₹8,769.21
    (c) ₹7,893.13
    (d) None of these

11. ABC Ltd wants to lease out an asset costing ₹3,60,000 for a 5 year period. It has fixed rental of ₹1,05,000 p.a. payable annually starting from the end of first year. Suppose rate of interest is 14% p.a. compounded annually on which money can be invested by the company. Is this agreement favourable to the company?
    (a) Favourable, ₹3,20,022.22
    (b) Unfavourable, ₹2,89,725.22
    (c) Unfavourable, ₹2,99,376.78
    (d) Favourable, ₹3,60,473.40

12. A machine with useful life of 7 years cost ₹10,000 while another machine with useful life of 5 yrs costs ₹8,000. The 1st machine saves labour expenses of ₹1,900 annually and the second one saves labourexpenses of ₹2,200 annually. Determine the preferred course of action. Assume cost of borrowing as 10% compounded p.a. Compute PV of cost savings -
    (a) No, ₹750.36
    (b) Yes, ₹8,339.74
    (c) No, ₹9,250.22
    (d) Yes, ₹5,366.63

13. A machine can be purchased for ₹50,000. Machine will contribute ₹12,000 p.a. for the next 5 years. Assume borrowing cost is 10% p.a. compounded annually. Determine whether machine should be purchased or not?Compute PV of Contribution -
    (a) Yes, ₹55,378.65
    (b) No, ₹48,800.00
    (c) No, ₹45,489.48
    (d) Yes, ₹52,366.71

14. An investor intends purchasing a three year ₹1,000 par value bond having nominal interest rate of 10%. At what price the bond may be purchased now if it matures at par and the investor requires a rate of return of 14%?
    (a) ₹1,026.29
    (b) ₹995.22
    (c) ₹826.36
    (d) ₹907.125

15. A 6 year bond of ₹1,000 has an annual rate of interest of 14%. Interest is paid half-yearly. If required rate of return is 16%, what is the value of the bond?
    (a) ₹925
    (b) ₹952
    (c) ₹950
    (d) ₹945

16. P Ltd has to make payment of ₹20 Lakhs in 60 days. The company has decided to invest in CDs of a leading Nationalised Bank at 8% p.a. What money is required to be invested now?
    (a) ₹19,74,040
    (b) ₹19,47,040
    (c) ₹19,78,040
    (d) ₹19,75,000

17. A money market instrument with face value of ₹100 and discount yield of 6% will mature in 45 days. Compute the current price of the instrument and effective annual return.
    (a) ₹99.05, 6.00%
    (b) ₹99.00, 5.29%
    (c) ₹99.25, 6.21%
    (d) ₹99.75, 6.08%

18. The value of furniture depreciates by 10% a year, if the present value of the furniture in an office is ₹21870, calculate the value of furniture 3 years ago
    (a) ₹ 30,000
    (b) ₹40,000
    (c) ₹ 35,000
    (d) ₹50,000

ANSWERS

4.1 SIMPLE INTEREST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
b	a	a	b	a	c	c	c	b	b	d	d	b	d	b	c	a	a	c	d

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
a	a	c	b	b	b	a	d	a	c	c	c	b	a	b	b	c	c	b	d	b	b

4.2 COMPOUND INTEREST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
b	c	b	a	b	c	d	b	a	a	c	a	c	a	c	c	a	b	b	a

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
d	a	c	d	b	b	b	c	c	a	d	c	a	b	c	b	a	c	b	c	d

42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
D	a	d	b	d	c	a	b	d	d	a	a	d	a	c	b	c	b	b	d	d	b	c	b	b

4.3 EFFECTIVE RATE OF INTEREST

1	2	3	4	5	6	7	8	9
a	c	c	c	a	c	b	c	d

4.4 ANNUITY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
b	b	b	a	b	a	d	b	d	a	b	c	a	a	c	b	a	a	a	c	d

22	23	24	25	26	27	28	29	30	31	32	33	34
b	c	b	a	b	c	a	d	c	d	b	c	b

4.5 APPLICATIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
a	b	a	b	c	a	c	b	c	a	d	b	c	d	a	a	c	a