Chapter XI

Basics of Financial Mathematics

Learning Objectives

After completion of this unit the students will be able to

- explain the origin and history of interest rate
- learn various forms of interest rate
- comprehend practical applications of interest rate in real life situation.
- have an outlook of various economic theory associated with interest rate
- Explain the relevance of financial mathematics in business and personal life.
- Develop understanding on the concepts associated with financial mathematics.
- Explain the steps involved in the computation of Income Tax and GST.
- Develop understanding on the practical applications of net present value; present value interest factor; future value interest factor and annuity.
- Calculate electricity, water and other utility bills.

11.1 Introduction

Finance and Mathematics are pervasive. Be it business activities, economic activities and philanthropic activities, finance and mathematics goes hand in hand. In other words, they are complementary to each other. Even in our daily life we observe that almost every activity where there is usage of money finance and mathematics is applicable.

The topic of Financial Mathematics is an integration of finance and mathematics. This topic would assist immensely in comprehending the practical applications of significant concepts like, interest rate; annuity; net present value; discounting; compounding; electricity bills; water supply bills; other utility bills etc.

After reading this unit a student would be able to understand the basis of determination of interest rates on various banking and other financial products, thereby, developing the ability to select appropriate financial products on the basis of interest rate, annuity, discounting and compounding.

Further, this unit would impart practical knowledge pertaining to reading of electricity, water and other utility bills, thereby making them conversant about the grey areas, like, overcharging of bills; incorrect reading of the meters; faults in the meters; basis of calculation of electricity, water and other utility charges.

Unit Structure

Unit VII Basics of Financial Mathematics	**Sub-topics**
Interest and interest rate	Origin of the concept of interest; Forms of interest rate; practical applications of interest rate; economic theories associated with interest rate.
Accumulation with simple and compound interest	Meaning and significance of simple and compound interest; formulae; calculations under simple and compound interest rates; compound interest rates application on various financial products etc.

	Video Link for reference: https://www.khanacademy.org/economics-finance-domain/core-finance/interest-tutorial/compound-interest-tutorial/v/introduction-to-compound-interest
Simple and compound interest rates with equivalency	Annual Equivalent Rate Youtube link: https://www.youtube.com/watch?v=1gxpwItFInw
Effective rate of interest	Concept and practical applications, especially in calculating coupon interests on bonds / debentures, wherein interest is compounded half yearly / quarterly. Youtube link: https://www.youtube.com/watch?v=86_OAx0E6kI
Present value, net present value and future value	Concept and its applications; concept of compounding and discounting; usage of PVAF, FVAF tables; computation of net present value; application of net present value in capital budgeting decisions etc. Youtube link: https://www.youtube.com/watch?v=zGRVVSC4UUQ https://www.youtube.com/watch?v=Dtot7qLEtPc Case studies / Caselets on net present value from various reference books on Financial Management would be discussed.

Annuities, calculating value of regular annuity	Immediate Annuity; Annuity Due; Deferred Annuity; Perpetuity and General Annuity Youtube link: https://www.youtube.com/watch?v=Rq66DqfDQf8 https://www.youtube.com/watch?v=joBu9TnFngQ
Simple applications of regular annuities (up to 3 period)	----------do----------
Tax, calculation of tax and simple applications of tax calculation in Goods and service tax, Income Tax	Fundamentals of taxation; direct and indirect tax; tax incidence and impact; Income Tax- Assessment of Individuals; GST- Integrated Goods and Services (IGST); State Goods and Services Tax (SGST); Central Goods and Services Tax (CGST) and Union Territory Goods and Services Tax (UTGST). Calculation of GST in hospitality sector; power sector etc. Project: Practical questions from various reference books on Income Tax and Indirect Tax (GST) would be discussed.
Bills, tariff rates, fixed charge, surcharge, service charge	Types of bills; tariff rates- its basis of determination; concept of fixed charge; service charge and their applications in various sectors of Indian economy. Refer: https://www.dvvnl.org/UploadFiles/tariffPlan/NPCL%20Tariff%20Order%20-%20Ver%207.pdf
Calculation and interpretation of	Crucial components of electricity bill; water supply and other supply bills; overcharging of electricity and

electricity bill, water supply bill and other supply bills	water supply bills; units consumed in electricity bills; consumer protection laws for redressal of complaints relating to overcharging in electricty, water supply and other supply bills; concept of Ombudsman. Youtube link: https://www.youtube.com/watch?v=4WG8TBi50xU https://www.youtube.com/watch?v=x5lnOgkdBic Refer: https://www.theenergydetective.com/bills Project: Students would be assigned with the task of taking reading of power consumption of various electrical gadgets installed in their residence and compute the electricity bill based on the KWH concept.
(Comparing interest rates on various types of savings; calculating income tax; electricity bills, water bill; service surcharge using realistic data)	Interest rates on various savings, fixed and recurring deposits products; steps involved in computation of income tax of individuals and factors considered; computation of electricity bills based on realistic consumption of electric units of households in delhi (data may be accessed from BSES Rajdhani Power Ltd.)

11.2 INTEREST & INTEREST RATES

Before you start you should know how to:

Familiarize with different banking transactions helpful in getting a quick overview of the concepts. However, this topic is an attempt to cover everything from very basics and emphasis is given to cover any missing grounds.

In simple terms, Interest is a fee charged on the money that is borrowed.

When you borrow money from a bank, you pay interest for the use of banks money. When you deposit money in the Savings Account you are paid interest.

When you borrow money from someone or use somebody else's money

↓

You have to pay service charge to him.

↓

This amount is paid back to the lender along with the original amount borrowed.

↓

This is known as INTEREST

Origin of the Concept of interest

Simply put, Interest rate is the cost of borrowing or the price for lending. However, the meaning of interest rate kept on evolving through time and civilizations.In the ancient middle eastern civilization, the practice of "food money" was prevalent. People lent seeds and livestock to others in exchange for more amount or numbers of the same in return. The argument behind this was that seeds and livestock could reproduce and multiply in numbers. But when coins became a medium for exchange, and since coins can not multiply on its own, the concept of interest rate on the coins borrowed was introduced.

In the medieval era loans were obtained mostly during period of extremities like a bad harvest. Since under such circumstances charging interest was viewed morally wrong, religious institutions forbade interest. The argument was that loans were used for consumption and not production.

But in the modern era, with the advent of industrialization and urbanization, people borrowed money with the intention of production and starting new businesses. Thus, many financial institutions came up to provide loans at attractive interest rates.

Earning Interest: When you save money in the bank, they will pay you to let them look after your money. This is called Earning Interest.

Example- If you save ₹ 100 in an account with an interest rate of 5%, after a year you will have ₹105.

Earning Interest is a kind of income for a person on the money invested by him.

Paying Interest: If you borrow money, banks will charge you for this. This extra charge is called Paying Interest.

Example- If you borrow ₹ 100 with an Interest Rate of 15%, after a year you will owe them ₹ 115.

Paying interest is a kind of expense for a person on the money borrowed by him.

What is Interest Rate: An Interest Rate is the amount of interest due per period, as a proportion of the amount lent, deposited or borrowed (called the principal amount). So, an interest rate is the percentage of principal charged by the lender for the use of its money.

An Interest Rate is the overall amount that has to be paid back over and above the original amount borrowed.

Interest Rates can be low or high depending on situation to situation.

Impact of Interest Rates:

If Interest Rates are Low?

If the Interest Rates are lowered, this is positive for the consumers as their mortgage repayments are low. Also, lower interest rates means it is less worthwhile to save money in the banks as the interest earned is low. The higher the Interest rate, the more consumers earn by saving their money in the bank.

If Interest Rates are High?

If the Interest Rates are high, this is negative for the business because they have increased costs in relation to their loan repayments. On the other hand, higher interest rates mean it is more worthwhile to save money in the banks as the interest earned is high.

Offered Interest Rates vary from product to product and from bank to bank with no. of factors contributing to the rate of Interest.

Types of Interest Rates:

There are essentially three main types of interest rates:

i) **Nominal Interest Rate -** The nominal interest of an investment or loan is simplified the stated rate on which the interest payments are calculated. Essentially, this is the rate on which savings accrue interest over a period of time.

For example: Investment of ₹ 10,000 at a nominal interest rate of 5% over 1 year would earn the investor ₹ 500.

ii) **Effective Rate -** The effective Interest Rate takes into account compounding over the full term of the investment. It is often used to compare annual rates with different compounding term (daily, monthly, annually, etc.)

iii) **Real Interest Rate -** It is useful when considering the impact of inflation on the nominal interest rate.

11.3 ACCUMULATION WITH SIMPLE AND COMPOUND INTEREST

Interest is charged using one or two methods. These are-

i) **SIMPLE INTEREST METHOD-** Under this method, the interest is charged only on the amount originally lent (principal amount) to the borrower. Interest is not charged on any accumulated interest under this method.

Formula for calculating Interest under Simple

Interest Method- Interest = P x i x n

Where: **P = Principal Amount**

i = Interest Rate

n = No. of periods

Example: A loan of ` 10,000 has been issued for 6 years. Compute the amount to be repaid by the borrower to the lender if simple interest is charged @ 5% per year.

Solution : P = ₹ 10,000, i = 5%, n = 6

By putting the values of P, i , n into the simple interest formula-

I = P x i x n

= 10,000 X 5% X 6

= ₹ 3,000

At the end of 6th year, the amount=Principle + Interest of ₹ 10,000 + ₹ 3,000 = ₹ 13,000 will be repaid to the lender.

ii) **COMPOUND INTEREST METHOD-** Under this method, the Interest is charged on the principal plus any accumulated interest. The amount of Interest for a period is added to the amount of principal to compute the Interest for next period. In other words, the interest is reinvested to earn more interest. The interest may be compounded monthly, quarterly, semiannually or annually.

When interest is added to the Principal amount, the resulting figure is known as Compound Amount.

Formula for calculating Compound Amount and Compound Interest.

Compound Amount Formula: $A = P (I + i)^n$

Where:

A = Compound Amount

P = Principal Amount

i = Interest Rate

n = No. of Periods

Compound Interest Formula

Compound Interest = Compound Amount (-) Principle Amount

Principal Amount

Example: The Bank has issued a loan of ₹ 1000 to a sole proprietor for a period of 5 years. The Interest Rate for this loan is 5% and the Interest is compounded annually. Compute -

(1) Compound Amount

(2) Compound Interest

Solution: Computation of Compound Amount:

$$\mathbf{A = P\ (I + i)^n}$$

$$= 1000 \times (I + 5\%)^5$$

$$= 1000 \times (I + 0.05)^5$$

$$= 1000 \times (1.05)^5$$

$$= 1000 \times 1.276'$$

$$= ₹\ 1276$$

Interest

1) Divide ₹ 43500 into two parts so that the simple interest an the fist when deposited for one year at 9% per annum and that on the second when deposited for 2 years at 10% per annum in a bank are the same.

Solution: Let the first part be x then 2nd part (43500-x)

$$SI = \frac{x.9.1}{100} = \frac{9x}{100} \ldots\ldots.(i)$$

for 2nd part $SI = \frac{(43500 - x).10.2}{100} \ldots..(ii)$

from question

$$\frac{9x}{100} = \frac{(43500 - x)20}{100}$$

$9x = 87000\text{-}20x$

$x = ₹\,30000$

Therefore, $43500 - x = ₹13500$

2) At what rate percen per annum will a sum of money tripple in 16 years

Solution : Let $P = x$

$A = 3x$

$SI = 3x - x = ₹\,2x$

$$R = \frac{SI \times 100}{P \times T} = \frac{2x \times 100}{x \times 16} = 12.5\%$$

3) A Sum of money lent art at simple interest amount to ₹ 2200 in one year and ₹ 2800 in 4 years. Find the sum of money and the rate of interest

Solution : A: Let $P = x$

$$\text{Amount} = P + \frac{Prt}{100} = 2200 = P(100 + r) = 2200 \times 100 \quad (\text{time} = 1\,\text{yr}) \ldots\ldots (i)$$

Again : Amount in 4 years

$$A = P + \frac{Pr.4}{100} = 2800 = P(100 + 4r) = 2800 \times 100 \ldots\ldots (ii)$$

Dividing (ii) by (i)

$$\frac{\cancel{P}(100 + 4r)}{\cancel{P}(100 + r)} = \frac{2800 \times 100}{2200 \times 100} = \frac{28}{22} = \frac{14}{11}$$

$1100 + 44r = 1400 + 14r$

$30r = 300 = r = 10\%$

From equation 1 $P(100 + 10) = 2200 \times 100$

$$P = \frac{\overset{20}{\cancel{2200}} \times 100}{\cancel{110}} = ₹\,2000$$

Computation of Compound Interest:

Once the Compound Amount has been computed, the amount of interest earned over the investment period can be computed by subtracting Principal amount from Compound Amount.

In this example, the Principal Amount is ₹ 1000 and the Compound Amount as computed above is ₹ 1276. The amount of Compound Interest for the 5 years period can be computed as follows:

Compound Interest = Compound Amount (-) Principle Amount

= 1276 - 1000

= ₹ 276

11.4 SIMPLE AND COMPOUND INTEREST RATES WITH EQUIVALENCY

- Compound Interest is the addition of interest to the principal sum of a loan or deposit or in other words interest on interest. It is the result of reinvesting interest, rather than paying out, so that the interest in the next period is then earned on the principal sum plus the previously accumulated interest. Compound Interest is standard in finance and economics.

- Compound Interest is contrasted with simple interest, where previously accumulated interest is not added to the principal amount of the current period, so there is no compounding. The simple annual interest rate is the Interest amount per period, multiplied by the number of periods per year. The simple annual interest rate is also known as the Nominal interest Rate.

  (not to be confused with the interest rate not adjusted for inflation, which goes by the same name).

- **Concept of Equivalency -** The nominal rate cannot be directly compared between loans with different compounding frequencies. Both the nominal interest rate and the compounding frequency are required in order to compare interest-bearing financial instruments.

  To help the consumers compare retail financial products more fairly

and easily, many countries require financial institutions to disclose the annual compound interest rate on deposits or advances on a comparable basis.

The Interest Rate on an annual equivalent basis may be referred to variously in different markets as Annual Percentage Rate (APR), Annual Equivalent Rate (AER), effective interest rate, effective annual rate, annual percentage yield and other terms. The effective annual rate is the total accumulated interest that would be payable up to the end of one year, divided by the principal sum.

- There are usually two aspects to the rules defining these rates:-

  1) The rate is the annualized compound interest rateand

  2) There may be charges other than interest. The effect of fees or taxes which the customer is charged and which are directly related to the product, may be included. Exactly which fees and taxes are included or excluded varies by country may or may not be comparable between jurisdictions because the use of such terms may be inconsistent, vary according to local practices.

Compound Interest

1. Find the amount of Rs 20,000 after 10 years at 8% converted quarterly for the first 4 year and at 6% compounded monthly thereafter.

Ans. : Case - 1

For the first 4 years

$n1 = 4 \times 4 = 16 \text{years}$

$\text{rate} = i_1 = \frac{8}{4 \times 100} = 0.02$

Case - 2 for the next 6 years

$n_2 = 6 \times 12 = 72$

$i_2 = \frac{6}{12 \text{x} 100} = 0.005$

Amount on compound interest CI after 10 years

$$= P(1+i_1)^{n_1}\ (1+i_2)^{n_2}$$
$$= 20000(1+0.02)^{16}\ (1+0.005)^{72}$$
$$= 20000\times(1+0.02)^{16}\times(1.005)^{72}$$
$$= 20000\times1.3727\times1.4320$$
$$= \quad 39314.128 \quad = \quad 39314.13$$

2) The difference between the CI and SI on a centrain sum of money at 40% per annum for 2 years is Rs 500. Find the sum

Ans. Let principal P= 9

$$SI = \frac{P\times10\times2}{100} = \frac{P}{5}$$

$$CI = P\left[\left(1+\frac{10}{100}\right)^2 - 1\right] = P\left(\frac{121-100}{100}\right) = \frac{21}{100}p$$

$$\because \quad \frac{21}{100}P - \frac{P}{5} = 500$$

$$\Rightarrow \quad 21P - 20P = 500\times100$$

$$\Rightarrow \quad P = ₹\,50000$$

Example:

(a) ₹1000 is deposited into savings account paying 20% per annum. Compounded annually. At the end of 1 year Compound interest 1000 X 20% = ₹ 200

Interest rate is credited to the account Amount = 1000+200 = ₹ 1200. The account then earns Compound interest of 1200 X 20% = ₹ 240 in the second year.

(b) A rate of 1% per month is equivalent to a simple annual interest rate (nominal rate) of 12%but allowing for the effect of compounding the annual equivalent compound rate is 12.68% per annum $\{(1.01)^{12}-1\}$

(c) The Interest on Corporate Bonds and Government Bonds is usually payable twice yearly. The amount of interest paid (each

six months) is the disclosed interest rate divided by two and multiplied by the principal. The yearly compounded rate is higher than the disclosed rate.

- It is sometimes mathematically simpler to use continous compounding which is the limit as the compounding period approaches zero.
- Continuous compounding can be thought of as making the compounding period infinitely small, which is achieved by taking the limit as n goes to infinity.

Practical Application of interest rate:

Let us try to understand application of interest rates from a bank's perspective. A bank is a financial institution which engages in borrowing and lending with public and private entities. Bank charges interest on lending and provides interest upon borrowing. The fine balance between the two interest rates drives the character of the economy. Borrowers come to bank for loans for businesses, education, personal and various other purposes. The bank agrees to do so but at a certain fixed rate. The bank may not always have all the money by itself to lend. So, it offers an attractive interest to entities agreeing to deposit their money with the bank. So, from a bank's perspective higher positive interest rate is the result of lack of sufficient loanable amount. This encourages entities to deposit and save more. A situation when a bank is getting overwhelmed with deposits of fund, the interest comes down encouraging entities to take loans and spend more. In certain rare situations, like aeconomic recession, the rate may approach the limiting value of zero discouraging savings and encouraging more and more spending. It is interesting to note that in recent times many countries like Sweden, Switzerland, and Japan have implemented negative interest rate making savings an unattractive option. This tends to be the case when people hoard more and more money without spending it.

Clearly, interest rate is a very important tool for the government, financial and regulatory institutions to control and regulate the character of the economy.

Economic Theory associated with interest rate:

The great Greek philosopher Aristotle's view had a great influence on the society. He condemned the charging of interest on lending money as "unnatural". He believed that the nature of money is to facilitate exchange and was strongly against making gain from money itself.

David Hume's classic essay "of money" had an important proposition on interest and its variations. He argued that interest depends on demand for borrowing, riches to supply demand and profits arising from commerce.

The classical theory of interest, which had contributions from a number of economists, argued that interest rate ensures equilibrium between demand for borrowing and lending.

Henceforth, many more sophisticated theories of economics were proposed which made great contributions to the development and understanding of the concept of interest. However, discussion of those would be beyond the scope of this chapter.

11.5 EFFECTIVE RATE OF INTEREST

The effective rate of interest is the real return on a savings account or any interest paying investment when the effects of compounding over time are taken into consideration.

It reveals the real percentage rate owed in the interest on a loan, a credit card or any debt.

It is also known as - the Effective Rate or the Annual Equivalent Rate.

- **Concept of Effective Interest Rate -** A bank certificate of deposit, a savings account or a loan offer may be advertised with its nominal interest rate as well as its effective annual interest rate.

  The nominal interest rate does not reflect the effects of compounding interest that comes up with these financial products. The effective annual interest rate is the real return.

KEY POINT: The more frequent the compounding periods, the greater the return.

Formula for Interest Rate which is Effective:

Effective Annual Interest Rate = $(1 + i/n)^{n} - 1$

Where: i= Nominal Interest Rate

n = Number of Periods

Example of Effective Annual Interest Rate:

Consider two offers:

- Investment A pays 10 % interest, compounded monthly.
- Investment B pays 10.1 % compounded semi-annually.

Which is better offer?

Solution: In both the cases the advertised interest rate is the nominal interest rate. The effective annual interest rate is calculated by adjusting the nominal interest rate for the number of compounding periods the financial product will experience in a period of time. In this case, that period is one year.

Following are the calculations:-

Effective Annual Interest Rate for A & B

Investment A = $(1 + 10\% / 12)^{12} - 1 = 10.47\%$

Investment B = $(1 + 10.1\% / 2)^{2} - 1 = 10.36\%$

CONCLUSION: Investment B has a higher stated nominal interest rate, but the effective annual interest rate is lower than the effective rate for Investment A. This is because Investment B compounds fewer times over the course of the year.

- **Concept of More Frequent Compounding Equals Higher Returns -** As the number of compounding periods increases, so does the effective annual interest rate. Quarterly compounding produces higher returns

than semi-annual compounding, monthly compounding more than quarterly, and daily compounding more than monthly.

Below is the breakdown of the results of these different compound periods with a 10% nominal interest rate-

Semi-annually	=	10.250%
Quarterly	=	10.381%
Monthly	=	10.471%
Daily	=	10.516%

The Limits of Compounding- There is a ceiling to the compounding phenomenon. Even if compounding occurs an infinite amount of times - not just every second or microsecond but continuously - the limit of compounding is reached.

Short trick for calculating Effective Interest Rate(to be solved on Calculator)

Base = 1 year

- R/ 100 + 1 X 100 = -100 = Effective Rate (Yearly)
  → 1 time
- R/ 200 + 1 X 100 = -100 = Effective Rate (Half Yearly)
  → 2 times
- R/ 400 + 1 X 100 = -100 = Effective Rate (Quarterly)
  → 4 times
- R/ 1200 + 1 X 100 = -100 = Effective Rate (Monthly)
  → 12 times

11.6 PRESENT VALUE, NET PRESENT VALUE AND FUTURE VALUE

❖ **Present Value:** The concept of present value is one of the most fundamental and pervasive in the world of finance. It is the basis for stock pricing, bond pricing, banking, insurance, etc.

In simpler terms, present value accounts for time value of money.

Present Value describes how much a future sum of money is worth today. It accounts for the fact that money we receive today can be invested today to earn a return.

Formula for Present Value

$$PV = \frac{CF}{(1+r)^n}$$

Where:

CF = Cash Flow in Future Period

r = Periodic Rate of return or Interest (also called the discount rate or the required rate of return)

n = no. of periods

▲ **Present Value explained through an Example:** Assume that you would like to put money in an account today to make sure you have enough money in 10 years to buy a car. If you would like to have ₹10,000 in 10 years and you know you can get 5% interest per year from a savings account during that time, howmuch should you put in the account now?

Applying the Present Value formula-

CF = ₹10,000

r = 5%

n = 10

So, $PV = \frac{CF}{(1+r)^n}$

$= \frac{10,000}{(1+0.05)^{10}}$

= ₹6139.13

Interpretation: Thus, ₹ 6139.13 will give you ₹10,000 in 10 years if you can earn 5% each year. In other words, the present value of ₹10,000 is ₹6,139.13

- **Net Present Value (NPV) :** Net Present value is the difference between the present value of cash inflows and the present value of cash outflow over a period of time.

Net Present Value is used to analyse the profitability of a project.

Formula for calculating NPV

$$NPV = \sum_{n=1}^{N} \frac{CFn}{(1+i)^n} - \text{Initial Cash Investment}$$

Where:

n = Cash Flow Period

i = Interest Rate Assumption

What is Positive NPV ???

A positive NPV indicates that the projected earnings generated by a project or investment exceeds the anticipated costs.

It is assumed that an investment with a positive NPV will be profitable and an investment with a negative NPV will result in Net loss. This concept is the basis for the Net Present Value Rule, which dictates that only investments with positive NPV values should be considered.

NPV's can be calculated by using tables, spreadsheets etc.

Illustration:

Let us say X Ltd. wants to expand its business and so it is willing to invest ₹10,00,000

The investment will bring an inflow of ₹1,00,000 in first year, ₹2,50,000 in the second year, ₹3,50,000 in the third year, ₹2,65,000 in the fourth year and ₹4,15,000 in the fifth year. Assume the discount rate to be 9%.

Let us calculate NPV using the formula

Year	Flow	Present Value	Computation
0	10,00,000	10,00,000	———————
1	1,00,000	+91743	100000 / (1.09)
2	2,50,000	+2,10,419	250000 / $(1.09)^2$
3	3,50,000	+ 270264	350000 / $(1.09)^3$
4	2,65,000	+187732	265000 / $(1.09)^4$
5	4,15,000	+269721	415000 / $(1.09)^5$
		+29881	

Hence NPV is ₹29,881

Interpretation:

Since the NPV is positive, the investment is profitable and hence X Ltd. Can go ahead with the expansion.

Future Value

Future Value is the value of an asset at a specific date. It measures the nominal future sum of money that a given sum of money is 'worth' at a specified time in the future assuming a certain interest rate, that is, the rate of return. It is the present value multiplied by the accumulation function.

The value does not include corrections for inflation or other factors that affect the true value of money in future.

Understanding Future Value : The future value calculation allows the investors to predict, with varying degree of accuracy, the amount of profit that can be generated by different investments. Investors are able to reasonably assume an investment's profit using the future value calculation.

Determining the future value (FV) of a market investment can be challenging because of market's volatility.

Types of Future Value:

- Future value using simple Annual Interest-

It assumes a constant rate of growth and a single upfront payment left untouched for the duration of investment.

If an investment earns simple interest, then the future value (FV) Formula is -

FV = I x (1 +(R X T))

Where:

I = Investment Amount

R=Interest Rate

T=No. of years

Example: Assume ₹1000 investment is held for 5 years in savings account with 10% simple interest paid annually. In this case the FV is ₹1000 (1 +(0.10 X 5)) = ₹1500

- Future value using Compounded Annual Interest-

With compounded interest, the rate is applied to each period's cumulative account balance. The formula for calculating the Future value of investment earning Compound Interest is

$FV = I X (1 + R)^{T}$

Where:

I = Investment Amount

R = Interest Rate

T = No. of Years

Example: Using the above example, the same ₹1000 for 5 years with 10% compounding interest rate would have future value of ₹1000 x $((1+0.10)^{5})$ = ₹ 1610.51

11.7 ANNUITIES, CALCULATING VALUE OF REGULAR ANNUITY

An annuity is a series of payments made at equal intervals.

Examples of annuities are regular deposits to a savings account, monthly

home mortgage payments, monthly insurance payments, pension payments etc.

Annuities can be classified by the frequency of payment dates. The payments may be made weekly, monthly, quarterly, yearly or any other regular interval of time.

An annuity which provides for payments for the remainder of a person's lifetime is a life annuity.

Types of Annuity:

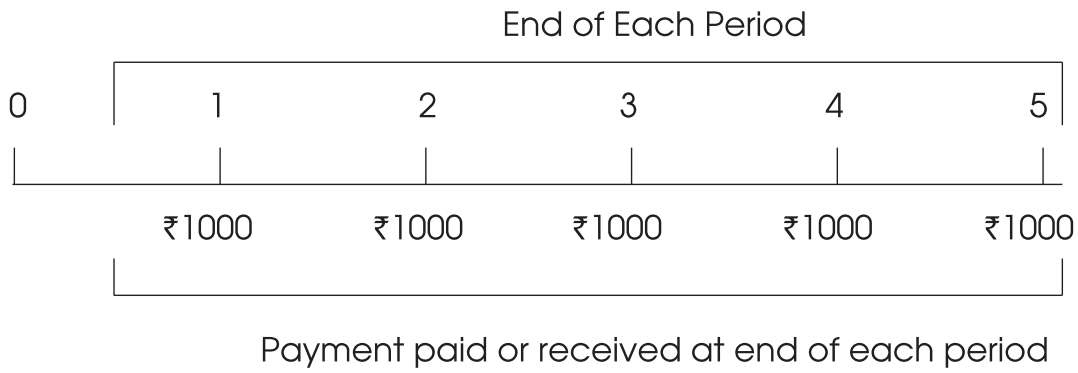
i) **Ordinary Annuity :** An ordinary annuity makes payments at the end of each period. For example - Bonds generally pay interest at the end of every six month, Example : Repayment of housing load of equal instalments.

ii) **Annuity Due :** With an annuity due, by contrast, payments come at the beginning of each period. For example - Rent, which the landlords typically require at the beginning of each month is a common example a) LIC Payment c) Recurring deposit Payment.

iii) **Deferred Annuity :** An annuity which is payable after the tapse of a number of periods is called deferred annuity. Example : Pension Plan of LIC, ordinary annuity is also known as Annuity immediate.

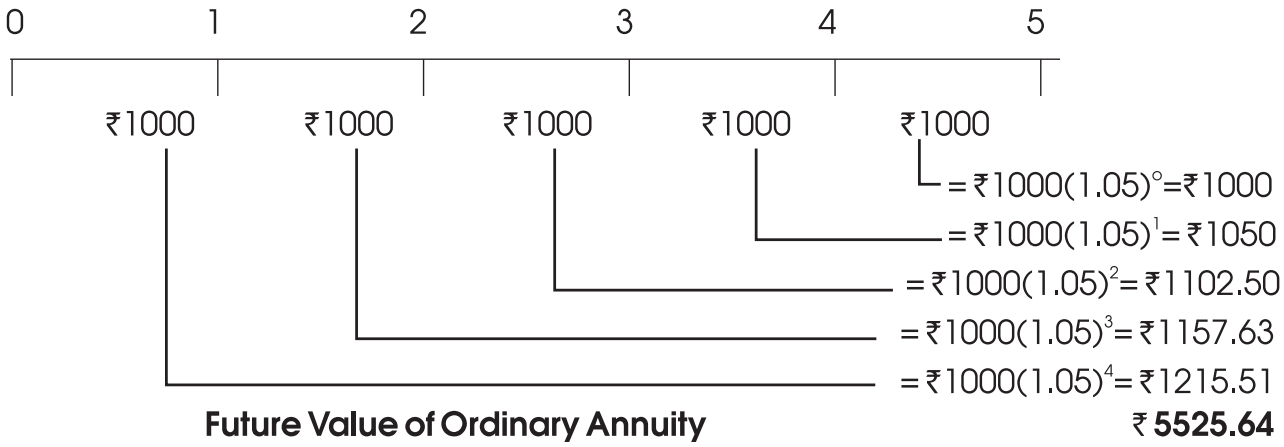
If a person plan to invest a certain amount each month or year, it will tell how much will it have accumulated as of future date.

For Example: A series of five ₹ 1000 payments made at regular intervals-



Let us assume that you invest ₹1000 every year for next 5 years at 5% Interest.

This is how much you have at the end of five year period -



Future Value of Ordinary Annuity **₹ 5525.64**

Characteristics of Annuity

a) Same amounts is paid at equal time interval

b) Instalments are due at the end of each period or at the beginning of each period.

Formula for Future Value

$$\textbf{FV} = C \times \left[\frac{(1+i)^n - 1}{i} \right]$$

Ordinary Annuity

Where: C = Cash Flow per period

i = Interest rate

n = Number of Payments

In above example-

$$\text{Annuity} = ₹1000 \times \left[\frac{(1+0.05)^5 - 1}{0.05} \right]$$

$$= ₹1000 \times 5.53$$

= ₹ 5,525.63 or 5525.64 (roundoff)

Formula for Present Value

$$\textbf{PV} = C \times \left[\frac{(1-(1+i)^{-n}}{i} \right]$$

Ordinary Annuity

In above example-

PV

Ordinary Annuity $= ₹1000 \times \left[\frac{(1-(1+0.05)^{-5}}{0.05}\right]$

$= ₹1000 \times 4.33$

$= ₹4329.49$

Example 1 : A man deposits in a bank Rs 16000 at the end of each year, for 8 years, If the rate of interest is 10% per annum compounded annually. What would be the sum standing to his credit at the end of that period.

Ans: $C = 16000, i = \frac{r}{100} = \frac{10}{100} = 0.1$

$n = 8$ years

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

$= \frac{160000}{001}\left((1+0.1)^8 - 1\right)$

$= 160000\ \left((101)^8 - 1\right)$

Let $x = (1.1)^8$

$\log\ x = 8 \log 1.1$ (taking log both sides)

$= 8 \times 0.0414 = 0.3312$

$x = \text{anti log}\ 0.3312 = 2.144$

$\therefore A = 16000(2.144 - 1) = 16000 \times 1.144 = \text{Rs.}18304$

Example 2 : Find the least number of years for which an ordinary annuity of Rs 1500 per annum must run in order that its amount just exceeds Rs 30000 at 9% compound annually

Ans.: A= Rs 30000, a= Rs. 1500

$i = \frac{9}{100} = 0.09$

we have

$A = \frac{a}{i}\left((1+i)^n - 1\right)$

$3000 = \frac{1500}{0.09}\left((1+0.09)^n - 1\right)$

$\frac{30000 \times 0.09}{1500 \times 100} = (1+0.09)^n - 1$

$$1+1.8=(1+0.09)^n$$

$$2.8=(1.09)^n$$

$$\text{Log } 2.8 = n \text{ Log} 1.09$$

$$0.4472 = n \times 0.0374$$

$$n=\frac{0.4472}{0.0374}=11.957 \cong 12 \text{ years}$$

Example 3 : A firm anticipates a Capital expenditure of Rs 100000 for a new equipment in 5 years. how much should be deposited quarterly in a sinking fund carrying 12% per annum compounded quarterly to provide for purchase.

Solution : Let Rs x per quarter be deposited

Instalment = Rs. x, Time = 5 years = 20 quarters

Rate = 12% p.a. = 30% per quarter

Amount = Rs 100000

$$\text{We know} \quad A=\frac{a\left((1+1)^n-1\right)}{i}$$

$$100000=\frac{x\left((1+\frac{3}{100})^{20}-1\right)}{0.03}$$

$$x=\frac{100000\times 0.03}{(1.03)^{20}-1}$$

$$\text{Let } \ p=(1.03)^{20}$$

$$\text{Log } p = 20 \text{ Log } 1.03$$

$$= 20 \times 0.0128 = 0.256$$

$$p = \text{antilog } 0.256 = 1.803$$

$$x=\frac{100000\times 0.03}{1.803-1}=\frac{100000\times 0.03}{803}=\frac{3000000}{803}$$

$$\text{Log } x = \text{Log } \frac{3000000}{803} = \text{Log } 3000000 - \text{Log } 803$$

$$= 6.4771 - 2.9047$$

$$= 3.5724$$

$$c = \text{Antilog } 3.5724 = \text{Rs. } 3736$$

Example 4 : Nidhi buys a LCD set worth Rs 48000 on instalment plan under which Rs 8000 is to be paid immediately and the balance in 15 equal instalment (annualy) with 18% per annum compound interest. How much has he to pay annually

Ans. : Cost of TV Set = Rs 48000

Down payment = Rs 8000

Balance = Rs 40000

Let each instalment = x

$$P = \frac{a(1-(1+i)^{-n}}{i}$$

$$40000 = \frac{x}{0.18}\left[1-(1+0.18)^{-15}\right]$$

$$= \frac{x}{0.18}\left[1-(1+18)^{-15}\right] \qquad .....(i)$$

Let $p = (1.18)^{-15}$

$\Rightarrow \text{Log } p = -15 \text{ Log } 1.18 = .15 \times 0.0719 = -1.0785$

$\Rightarrow p = \text{anti Log } (\bar{2}.9219) = 0.0834$

$$D \Rightarrow 40000 = \frac{x}{0.18}\left[1-0.08347\right]$$

$$\Rightarrow x = \frac{40000 \times 0.18}{0.91653} = \frac{72000}{9.1653}$$

$\text{Log } x = \text{Log } 72000 - \text{Log } 9.1653$

$= 4.8573 - 0.9621 = 3.8952$

$\Rightarrow$ xxxxxx = anti Log 3.8952 = 7856

hence each instalment = Rs. 7856

Example 5 : Same for a child's education, a family decides to invest Rs. 3000 at the end of each 6 month period in a fund paying 8% per year compounded semi annually. Find the amount of the investment at the end of 18 years.

Solution :

P = Rs 3000

n = 18 x 2 = 36

$$I = \frac{8}{2 \times 100} = 0.04$$

Let A be the amount of annuity then

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

$$= 3000\left[\frac{(1+0.04)^{36} - 1}{0.04}\right] = 3000\left[\frac{(1.04)^{36} - 1}{0.04}\right]$$

Let $x = (1.04)^{36}$

Log x = 36 Log 1.04 = 36 x 0.0170 = 0.612

x= Anti Log 0.612 = 4.093

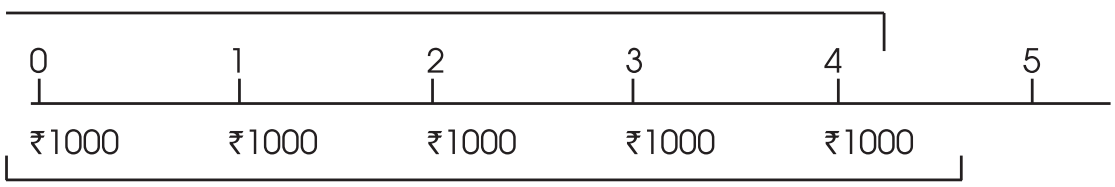
x = Anti Log 0.612 = 4.093

$$\therefore A = 3000 \frac{(4.093 - 1)}{0.04} = 3000\ (77.325) = 231975$$

Amount = Rs 231975

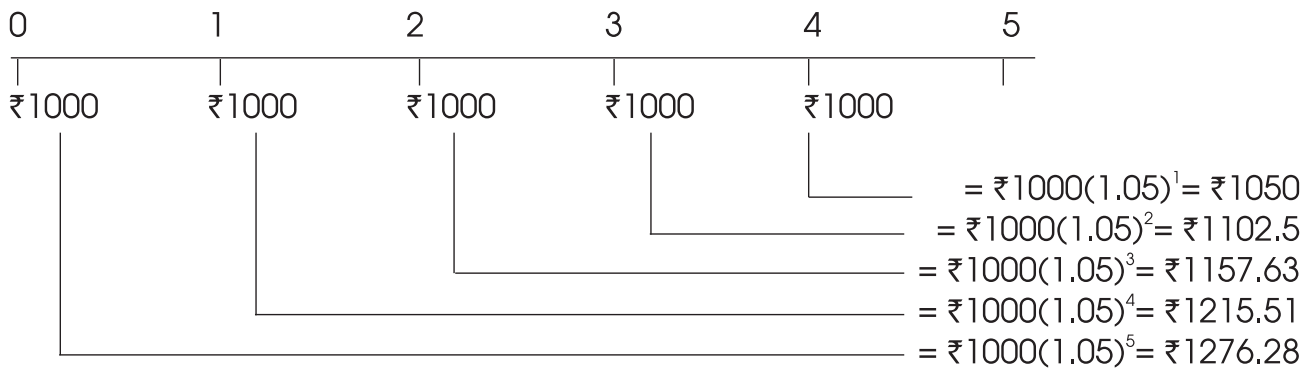
▲ Calculation of Future Value of Annuity Due

Beginning of Each Period



Payment paid or received at beginning of each period

Following the previous example-



Future Value of Annuity Due **₹ 5801.92**

Formula for Future Value

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

Annuity Due

In above example-

FV

Annuity Due = ₹ $1000 \times \left[\frac{(1+0.05)^5 - 1}{0.05}\right](1+0.05)$

$=$ ₹1000 x 5.53 x 1.05

$=$ ₹5801.92

Formula for Present Value

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

Annuity Due

In above example-

PV

Annuity Due = ₹ $1000 \times \left[\frac{(1-(1+0.05)^{-5}}{0.05}\right](1+0.05)$

$=$ ₹1000 x 4.33 x 1.05

$=$ ₹4545.95

11.8 SIMPLE APPLICATIONS OF REGULAR ANNUITIES (Upto 3 periods)

An annuity is a series of equal cash flows, equally distributed over time.

Examples of Annuities abound -

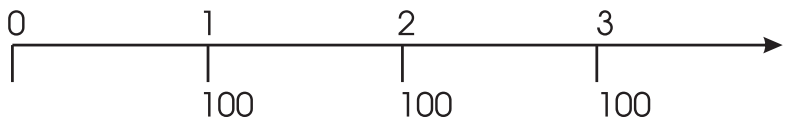
- Mortgage Payments

- Car Loan Payments
- Leases
- Rent Payment
- Insurance Payouts, and so on

If you are receiving or paying same amount of money every month (or week or year, or whatever time frame), then there is an annuity.

A regular annuity is simply an annuity where the first payment is made at the end of the period.

The picture below shows an example of a 3-period, `100 regular annuity.



Notice that we can view the annuity as a series of three Rs.100 lumpsums or we can treat the cash flows as a package.

Calculating the Future Value of a Regular Annuity

As noted, annuity can be treated as a series of lump sum cash flows.

$$FV_A = \sum_{t=1}^{N} CF_t(1+i)^{N-t}$$

Using the example shown in the time line (above) and a 9% period interest rate, we get -

$$FV_A = 100\,(1+0.09)^2 + 100\,(1+0.09) + 100$$

$$= ₹327.81$$

Analysis: Note that future value of regular annuity is in the same period as the last cash flow. So the first cash flow must be taken two periods forward, the second cash flow must be moved one period ahead and the last cash flow is already there, so it does not move at all.

Therefore, if the Interest Rate is 9%, then the future value of this annuity is ₹327.81 at the end of period 3.

The formula shown above works fine, but it is tedious if the annuity has more than a few payments. Fortunately, we can derive a closed form version of that equation which means that we don't have to iterate through a series of sums. The closed form equation is -

$$FV_A = Pmt\left[\frac{(1+i)^N - 1}{i}\right]$$

Where Pmt is the per period annuity payment amount(`100 in our example). This formula is much easier to use, no matter how many payments there are. In this case, it gives us -

$$FV_A = 100\left[\frac{(1+0.09)^3 - 1}{0.09}\right] = 327.81$$

which is exactly the same as we got previously.

Example: Imagine that you are planning to retire in 35 years and you think you can afford to save ₹500/- per month. Further, you believe that you can reasonably earn about 8% per year without taking too much risk.

How much amount will you have accumulated at the time you retire?

In this example, Pmt is ₹500/- because you plan to save that amount each and every month. The number of periods N is 420 months and the interest rate is 0.667% per month.

In this case, we are making monthly investments so both N and i must be converted to monthly values.

Solving the closed form equation, we find that you will have –

$$FV_A = 500\left[\frac{(1+0.00667)^{420} - 1}{0.00667}\right]$$

= ₹1,146,941.24/-

Interpretation: We just found that investing ₹500 per month @ 8% per year will result in the nest egg of ₹1146941 after 35 years.

11.9 TAX, CALCULATION OF TAX AND SIMPLE APPLICATION OF TAX CALCULATION IN GOODS AND SERVICE TAX, INCOME TAX

What is Tax?

Tax is money that people have to pay to the government.

A tax is a compulsory financial charge or some other type of levy which is imposed by a governmental organization in order to fund various public expenditures.

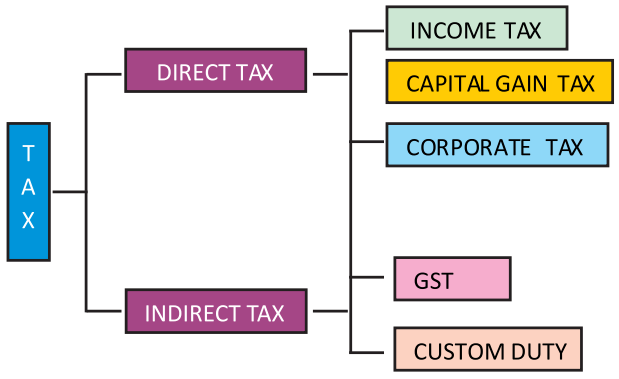
For example, taxes are used to pay for the people who work for the government, such as the military and the police, provide services such as the education and health care, and to maintain or build the things like roads, bridges etc.

So, taxes are the primary sources of income for the government through which it fulfills various projects and initiatives. Tax is vital for the country's economic progress, sustenance and development.

Taxes prevalent in India

In India there are two types of Taxes prevailing i.e. Direct Tax and Indirect Tax. Generally, taxes which are directly collected from tax payer are called Direct Taxes and taxes which are indirectly collected are called Indirect Taxes.

As you can see in below hierarchy, Direct Tax are further divided into Income Tax, Capital Gain Tax, Corporate Tax. Similarly, Indirect Taxes are further divided into two i.e. GST (Goods and Services Tax) and Custom Duty.



▲ Computation of Income Tax

Income from Salary	XXX
Income from House Property	XXX
Income from Business or Profession	XXX
Income from Capital Gains	XXX
Income from Other Sources	XXX
Gross Total Income	XXX
Less: Deductions (Limit `150000)	XXX
(PF, PPF, LIC, housing Loan, FD, NSC)	
Taxable Income	XXX

(Rebate of ₹12,500 is available if taxable income is upto ₹5,00,000)

Applicable Tax Rate

For the financial year 2020-21 (Assesment year 2021-2022) rate of income tax is as under

Slab	Income Tax Rate	Health and Education Cess
Upto 2.5 Lakh	Nil	4%
2.5 - 5.0 Lakh	5% of amount by which taxable income exceeds Rs 2,50,000	
5.0 - 7.5 Lakh	Rs 12500 + 10% (taxable income 2,50,000)	4%
7.5 - 10 Lakh	Rs 37500 + 15% (taxable income 7,50,000)	4%
10 - 12.5 Lakh	Rs 75000 + 20% (taxable income 10,00,000)	4%
12.5 - 15 Lakh	Rs 1,25000+25% (taxable income 12,50,000)	4%
Above 15 Lakh	Rs 187500 + 30% (taxable income 15,00,000)	4%

Example 1: Income from Salaries is ₹ 4,00,000 for the financial year 2019-20. Calculate Income Tax liability if the deductions under LIC is 50,000.

Solution -	Income from Salaries	₹ 4,00,000
	Gross Total Income	₹ 4,00,000
Less:	Deductions	₹ 50,000
	Taxable Income	₹ 3,50,000

Tax Calculation upto ₹ 2.50 lacs		NIL
	(₹350000 - ₹250000) X 5%	₹ 5,000
	TOTAL TAX	₹ 5,000

* Since Taxable Income (₹350000) is less than ₹500000, so Rebate of ₹12500 is available.

Hence total tax payable is NIL.

EXAMPLE 2 : Income from salaries is ₹2,00,000. Income earned from House property rentals ₹1,00,000. Income under head Business and Profession, come out to be ₹2,50,000. Income under head capital gain is ₹1,00,000.

PF contribution is ₹50,000, LIC is ₹50,000.

Calculate Income Tax Liability

SOLUTION :

	Income from Salary	2,00,000
	Income from house property	1,00,000
	Income from Business profession	2,50,000
	Income from Capital gains	1,00,000
	Gross total income	6,50,000
LESS : Deductions		
	PF contributions	(50,000)
	L I C	(50,000)
	Taxable Income	5,50,000

Calculation of Tax :

0 - 250000	NIL	
	(5,00,000 - 2,50,000) x 5%	12,500
	(5,50,000 - 5,00,000) x 20%	10,000
	Total Tax	22,500

- Since taxable Income is more than `5,00,000, no Rebate is available.

EXAMPLE 3 : Raman's monthly salary is Rs 1,93,800. HRA is 24% of Basic Salary and Transportation allowance is Rs 8424 per month. he deposits Rs 40,000 om GPF and pays Rs 45000 per month as the income tax for 11 month. How much income tax Raman still have to pay.

SOLUTION :

Salary : Rs. 1,93,800

$$\text{HRA} = \frac{1,93,800 \times 24}{100} = \text{Net } 46,512$$

TA = Rs 8240

Net monthly Salary = 1,93,800 + 46512 + 8424

= 2,48,736

Annual Salary = 12 x 248736 = 2,984,832

$$\text{Income tax} = 187500 + \frac{30}{100} \times (2,984,830 - 1500000)$$

$$= 6,32,949$$

$$\text{Health and education cess} = \frac{632949 \times 4}{100} = 25317.96 = 25318$$

Surcharge = 25% of Income Tax

$$= \frac{25}{100} \times 6,32,948 = 158237.25$$

$$= 158238$$

Net Income Tax = 6,32,949 + 25,318 + 1,58,237

= Rs. 816504

Tax already paid in 11 month =45000 x 11 = Rs 4,95,000

Tax Payable = - Rs 8,16,504

Rs 4,95,000

Rs. 3,21,504

Check Your Progress :

Q. Mr X had income from salary of ₹200000. Income from Capital Gain of ₹150000 and income from other sources is ₹250000. Contribution to PF is ₹40000, PPF `70000, and LIC is ₹40000. Calculate Income Tax Liability of Mr X.

Q. Mr A had Income from Salary of ₹300000. Income from House property rentals comes out to be ₹150000. Income from Capital gains is ₹300000. Income from other sources is ₹50000.

Deduction made under section 80 C

PF	-	₹ 40,000
PPF	-	₹ 40,000
Fixed deposits	-	₹ 30,000
LIC	-	₹ 40,000

Calculate Income Tax liability of Mr. A

About GST (Goods & Service Tax)

Goods and Services Tax which is abbreviated as GST is the form of Tax which has been Imposed by the Government of India at National Level. The GST levied by the Government of India on the sellers, manufacturers and consumers of goods and services at a National Level.

GST is derived from the concept of Value Added Tax which means that it is applied at each stage and the consumer is supposed to pay the GST amount which is charged by last dealer or the supplier in the supply chain.

Different Tax Heads under GST

GST can be categorized in four different heads such as _____

1. State Goods and Services Tax (SGST) - State Government collects this Tax.
2. Central Goods and Services Tax (CGST) - Central Government collects this Tax.

3. Union Territory Goods and Services Tax (UTGST) - Union Territory Government collects this tax.

4. Integrated Goods and Services Tax (IGST) - It is collected by the Central Government for Inter State transaction. IGST is also levied on import of goods and services into India and an export of goods act side India.

Remember

CGST + SGST : Revenue is shared equally between centre and state.
IGST - Revenue is collected by Central Govt and is shared with the State as the basic of destination of goods.

▲ **GST calculation formula**

For calculating GST, following mentioned formula can be used by the tax payer. Following formula helps to calculate net price of the product after application of GST and removing GST as well.

The formula for GST calculation -

1. Add GST

GST Amount = (original cost x GST %)/100

Net price = original cost + GST amount

2. Remove GST

GST Amount = original cost - (original cost x {100/(100+GST%)})

Net Price = original cost - GST Amount

Example - Lets assume that a product is sold for Rs. 2000 and GST applicable to that product is 12%.

Then the net price of the product becomes Rs. 2,000 + 12% of ₹2,000.

This comes out as ₹2,000 + ₹240 =₹2,240

11.10 BILLS, TARIFF RATES, FIXED CHARGE, SURCHARGE, SERVICE CHARGE

▲ BILLS

- A bill is a written statement of money that you owe for goods and services. If you bill someone for goods or services you have provided them with, you give or send them a bill stating how much money they owe you for these goods and services.

- Bill, also called as, Invoice or Tab is a commercial document issued by a seller to a buyer, relating to a sale transaction and indicating the products, quantities and agreed prices for the products or the services the seller had provided the buyer.

Example

INVOICE/BILL						
Company Name						
123, Wall Street						
Invoice No.						Date Terms
Description						Amount Owed
Invoice Total						[Currency]

- **Tariff Rates**

A tariff is a tax imposed by a government on good and services imported from other countries that serves to increase the price and make imports less desirable or atleast less competitive, versus domestic goods and services.

Tariffs are generally introduced as a means of restricting trade from particular countries or reducing the importation of specific types of goods and services.

For Example: In order to discourage the purchase of Italian leather handbags, the U.S government could introduce a tariff of 50% that

drives the purchase price of those bags so high that the domestic alternatives are much more afferable. The government's hope is that the added cost will make the imported goods much less desirable.

A rate is derived from the data in the tariff of rates, for example, schedules and rating tables. This rate is set forth by a rating organization.

- **Fixed Charge :**

A fixed charge is any type of expense that recurs on a regular basis, regardless of the volume of business.

Fixed charge mainly include loan (principal and interest) and lease payments.

- **Interpretation**

If your business borrows money from the bank, the bank may say it wants to take a fixed charge over a particular asset of your business, for example, your business premises.

This means if your business stops repaying the bank, it can seize your business premises and sell them to recover the money it owed.

Important

Holders of fixed charges takes precedence over most other creditors if business is liquidated. For example, if your business is in liquidation, a bank holding a fixed charge over your business's property would be entitled to be repaid first from the sale of property. Only money left over from that sale could go to the rest of the creditors. If you have given fixed charge on one of your business's assets, you can't usually sell that asset without permission from creditor who holds fixed charge.

- **Surcharge**

A surcharge is an extra fee, charge or tax that is added on to the cost of a good or service, beyond its initial price. Surcharge is 'Tax on Tax'. This charge reflects a locality's need to collect the money for extra services, a

hike to defray the cost of increased commodity pricing, such as with a fuel surcharge or extra fee on your wireless bill for access to emergency services.

Many Industries, including travel, telecom and cable will add surcharges to offset the cost of higher prices, such as fuel, or regulatory fees Imposed by the government.

Surcharge in relation to Taxes

Surcharge is an additional charge or tax levied on existing tax. It is levied as percentage on the income tax payable as per normal rates. In case, no tax is due for the financial year, then no surcharge is levied.

The revenue earned via surcharge is solely retained by the Centre and is not shared with the States. Collections from surcharge flow into the Consolidated Fund of India.

Service Charge

- A service charge is a fee collected to pay for the services related to the primary product or service being purchased. The charge is usually added at the time of the transaction.
- Many Industries collect service charges including restaurants, banking and travel and tourism. When collected, these charges may cover service rendered to the customer or they may cover administrative or processing costs.
- Service charges are paid directly to the company.

  For example - A concert venue may charge a service fee in addition to the initial price of a ticket at the time of purchase in order to cover the cost of security or for providing the convenience of electronic purchases.
- Service Charges are also called as Service Fees. They go by no. of different names depending on the industry, including booking fees (hotels), security fee (travel), maintenance fee (banking) and customer service fee.

GST

Question : A man buys a LCD at Rs 40,000 at a discount of 20% on printed price and sills it at printed price. If the sales are intra-state and the rate of GST in 12%

find

a) price a t which LCD is bought by retailer

b) price at which the consumer bought LCD

c) GST paid by retailer

d) GST paid by consumer

Ans : Rate of GST = 120% that will be shared by centre and states equally at 6%

cost of LCD = Rs. 40,000

$\text{Discount} = \frac{40000 \times 20}{100} = \text{Rs. } 8,000$

Net price of LCD = Rs 40,000 - Rs 8,000 = Rs 32,000

$\text{SGST paid by retailer} = \frac{6}{100} \times \text{Rs. } 32,000 = \text{Rs. } 1,920$

CGST paid by retailer to wholesaler =

Total GST paid by retailer to wholesaler = Rs 1,920 + Rs. 1920 = Rs 3,840

a) Purchase cost of LCD = Rs. 32,000 + Rs 3,840 = 35,840

b) Retailer sells the LCD at the fixed price

Consumer buys LCD at printed price Rs 40,000

$\text{SGST paid by the consumer to the retailer} = \frac{40000 \times 6}{100} \times \text{Rs. } 2400$

$\text{CGST paid by the consumer to retailer} = \frac{6}{100} \times \text{Rs. } 40,000 = \text{Rs. } 2,400$

Total GST paid by the consumer = Rs 2400 + Rs 2400 = Rs 4800

c) GST paid by the retailer to govt. Rs 4800 - Rs 3840 = Rs 960

d) GST paid by consumer = Rs 4,800

11.11 Calculation and Interpretation of Electricity Bill, Water Supply and other Supply Bills

Electricity Bill - A bill for money owed for electricity used.

- **Calculation and Interpretation**

The Electricity Bill is based upon the usage of appliances in the house over a monthly period.

All the appliances have a wattage label on them which tells what the device uses.

E.g. Toaster is 1 KW, kettle is 2400 Watt, lightbulb is 100 Watt, TV 85 Watts etc.

Most domestic customers are billed in kWh .

Bills are made up of a fixed component - line charges, network charges, which is based upon the size of the main fuse (s) 10, 30. You pay that regardless of any power used.

Then there is usage charge per KWh, (Unit) of cts/kWh.

- **Electricity bill explained through an Example**

TV is used 4 hours a day at 85 Watts/hour = $4 \times 85 = \frac{340}{1000} = 0.34 \text{ Kw / day}$

Toaster is used 15 minutes/day at 1000 Watts/hour = $\frac{15}{16} \times \frac{1000}{1000} = 0.25 \text{ Kwh}$

Kettle is used for 2 hours/day at 2400 Watts = $\frac{2400 \times 2}{1000} = 4.8\text{kwh / day}$

15 light bulbs for 5 hours / day at 100 watts = $\frac{15 \times 5 \times 100}{1000} = 7.5\text{kwh / day}$

Total daily usage = 12.89 kwh / day

Monthly usage 30 days x 12.89 kwh/ day = 386.7 kwh / months

Flat rate tariff at 22 cts / kwh = ₹85.07

Line charge Rs. 1.10 / day x 30 days = ₹33.00

So, total bill is ₹118 .07 for the month

Understanding

Domestic electricity bill is calculated after taking the energy consumption unit at your premises. Nowadays, latest electronic hand held devices are being used and the bill collector need not have to feed the units, as it is laser receiver,

and once it is put into the meter chamber it collects all the data and information about the consumers and a copy of print out comes from the device as electricity bill, and is handed over to the consumers on the spot . And, the total data of the day for the consumers will be fed to the computer for keeping the records. The Tariff applicable varies from state to state electricity boards. It will have many categories like domestic, commercial and industrial and place of worship and some are divided into sub groups to provide subsidies, from time to time as and when amended by the state governments.

Generally, domestic bill is calculated as per the slabs provided by the individual electricity boards. From 0-50, 51-100, 101- 200 and 200-300 above 301-500, likewise tariffs are made and fixed to control the consumption of power.

These slabs and tariff rates are taught to the billing meters.

Water Bills

- It is the amount one must pay to use water and sewage services each month. Normally water and sewage is provided by a municipality, but this is not always. Water supply bills are usually based upon one's usage , such as those who use more water are charged more.

- **Calculation and Interpretation Of Water Supply Bill**

The water bill consists of a service charge, consumption charges and 50% of consumption charges as Sewage maintenance charge

To understand, rates of services and consumption charge-

Service Charge	**Consumption Charge**	
	Consumption per month (litres)	
1. ₹40/- per month per connection for Residential premises having Build up area upto 200 sq. meters	0-,6000 7,000-20,000	0 2/-
2. ₹120/- per month per connection for residential premises having Build up area above 200 sq. metres	21,000-30,000 above 30,000	7/- 10/-

Clarification Regarding Service Charge

The Service charge leviable on the domestic consumers is as follows -

1. For a single water connection in a residential premise on a plot the service charges are leviable on the basis of the build up area of the ground floor of the premises, even if there may be a number of floors in the premises.

2. For multiple connections in any residential area /premises on a plot, service charges shall be leviable on each connection on the basis of build up area of the unit, being fed by the respective water connection.

For Example -

1. If on the ground floor of any premises there are more than one connection, then for each connection the service charge will be leviable on the basis of build up area of the premises served by each connection.

2. If there is only one water connection in a premises having multiple floors, the service charge will be leviable only on the build up area of the ground floor of premises against which connection is sanctioned.

3. For multiple water connections on the ground floor, feeding a residential premises on a plot area which has one or more than one floors, Service charge shall be liable against each water connection, as per build up area of ground floor only.

- **Calculate your water bill yourself**

Example - If Build up area of your house is up to 200 Sqmtrs. and -

- On one connection, if consumer consume water up to 6000 litres per month, consumption charges shall be NIL and monthly bill be ₹40/-.
- On one connection, if consumer consume 10,000 litres water per month, monthly bill will be ₹52/-.
- On one connection, if consumer consume 20,000 litres water per month, monthly bill will be ₹82/-.
- On one connection, if consumer consume 21,000 litres water per month, monthly bill will be ₹93/-.
- On one connection, if consumer consume 31,000 litres water per month, monthly bill will be ₹202/-.