

# Chapter 4 – Mathematics for Finance

# Time Value of Money

Interest

Annuity

Perpetuity

Miscellaneous Topics

Baap of All Questions

# Interest

```
graph TD; Interest[Interest] --- Simple[Simple Interest]; Interest --- Compound[Compound Interest];
```

Simple Interest

Compound Interest

# Simple Interest

## Meaning

Interest accrues only on the original Principal

## Formulas

$$I = Pit$$

$$A = P + I$$

Derivatives of these Formulas

$$A = P(1 + it)$$

$$i = \frac{A - P}{Pt}$$

$$t = \frac{A - P}{Pi}$$

## Important Points

P = Principal

i = Rate of Interest (in Decimal)

t = Time (in years)

# Compound Interest M

## Meaning

Interest is calculated not only on the original Principal, but also on the interest accrued on it.

## Formulas

$$A = P \left( 1 + \frac{i}{NOCPY} \right)^{t \times NOCPY}$$

$$CI = P \left[ \left( 1 + \frac{i}{NOCPY} \right)^{t \times NOCPY} - 1 \right]$$

## Important Points

NOCPY = No. of Conversion Periods Per Year 📅

Compounded Annually	NOCPY = 1
Compounded Semi-Annually	NOCPY = 2
Compounded Quarterly	NOCPY = 4
Compounded Monthly	NOCPY = 12

$$n = t \times NOCPY$$

# Compound Interest M

## Applications

### Depreciation

#### Important Points

Principal =  
Cost of  
Machine

Amount =  
Scrap  
Value

Rate of  
Depreciation  
has to be  
written in  
negative

### Effective Rate of Interest

#### Meaning

Ignoring the compounding of Annually/ Semi-Annually/ Quarterly/ Monthly, etc., what is the actual rate of interest which will fetch you the effective interest in a year

#### Formula

$$E = \left( 1 + \frac{i}{NOCPY} \right)^{i \times NOCPY} - 1$$

### Difference between CI and SI

#### Formula

$$CI - SI = P \left[ \left\{ (1+i)^t - 1 \right\} - it \right]$$

# Annuity <sup>M</sup>

Meaning

Types

Future Value

Present Value

# Annuity <sup>M</sup>

## Meaning

- 1) Fixed Amount
- 2) At Regular Intervals
- 3) For a Certain Period

## Types

### Annuity Regular/ Certain

Amount is paid/ received at the end of every period

### Annuity Due/ Immediate

Amount is paid/ received at the beginning of every period



# Annuity <sup>M</sup>

## Future Value

### Annuity Regular

#### Formula

$$FV = A \left[ \frac{\left(1 + \frac{i}{NOCPY}\right)^{t \times NOCPY} - 1}{\frac{i}{NOCPY}} \right]$$

#### Applications

##### Sinking Fund

The amount required from the Sinking Fund is the Future Value of Annuity

### Annuity Due

#### Formula

$$FV = \left[ A \left[ \frac{\left(1 + \frac{i}{NOCPY}\right)^{t \times NOCPY} - 1}{\frac{i}{NOCPY}} \right] \right] \times \left(1 + \frac{i}{NOCPY}\right)$$

# Annuity <sup>M</sup>

## Present Value

### Annuity Regular

### Annuity Due

#### Formula

$$PV = A \left[ \frac{\left(1 + \frac{i}{NOCPY}\right)^{t \times NOCPY} - 1}{\frac{i}{NOCPY} \times \left(1 + \frac{i}{NOCPY}\right)^{t \times NOCPY}} \right]$$

#### Applications

##### Loan

PV of all installments is equal to the Loan Amount.

##### Capital Expenditure

When a project is undertaken, the present value of all the inflows is compared with the present value of outflows. If the PV of inflows is greater than the PV of outflows, the project should be undertaken.

##### Net Present Value

When a project is undertaken, the present value of all the inflows is compared with the present value of the outflows. If the PV of Inflows is greater than PV of Outflows, the Net Present Value (NPV) is positive, and the project should be undertaken, otherwise, the project should not be undertaken.

##### Leasing

Leasing means Renting. When you're willing to take a machine on rent, you should compare it with its cost. If the cost is more than the Present Value of all the lease rentals that you're going to pay, then obviously, go for leasing, otherwise go for buying.

When you're willing to give a machine on rent, you should compare it with its selling price. If the selling price is more than the present value of all the lease rentals that you're going to receive, then obviously, go for selling, otherwise go for leasing.

##### Bond Valuation

Bond is a loan document which provides you interest at the coupon rate. It is redeemed at the end of the period at Par (as per your syllabus). The price of the bond should be either equal to or less than the Present Value of all the inflows.

#### Formula

PV of Annuity Due = Initial Receipt/ Payment + PV of Annuity Regular for (n - 1) periods

# Perpetuity M

Normal Perpetuity

$$\frac{A}{i / \text{NOCPPY}}$$

Growing Perpetuity

$$\frac{A}{i - g}$$