Bond Valuation

Study Session 10

LOS 1 : Introduction (Fixed Income Security)

Bonds are the type of long term obligation which pay periodic interest & repay the principal amount on maturity.

Three types of Cash Flows

(i) Interest
(ii) Principal Repayment
(iii) Re-Investment Income

Purpose of Bond's indenture & describe affirmative and negative covenants

- The contract that specifies all the rights and obligations of the issuer and the owners of a fixed income security is called the Bond indenture.
- These contract provisions are known as covenants and include both negative covenants (prohibitions on the borrower) and affirmative covenants (actions that the borrower promises to perform) sections.

1. Negative Covenants : This Includes

a) Restriction on asset sales (the company can't sell assets that have been pledged as collateral).
b) Negative pledge of collateral (the company can't claim that the same assets back several debt issues simultaneously).
c) Restriction on additional borrowings (the company can't borrow additional money unless certain financial conditions are met).

2. Affirmative Covenants: This Includes

a) Maintenance of certain financial ratios.
b) Timely payment of principal and interest.

Common Options embedded in a bond Issue, Options benefit the issuer or the Bondholder

- Security owner options:
  a) Conversion option
  b) Put provision
  c) Floors set a minimum on the coupon rate
- Security issuer option:
  a) Call provisions
  b) Prepayment options
  c) Caps set a maximum on the coupon rate

LOS 2 : Terms used in Bond Valuation

(i)	Face Value	₹ 1,000
(ii)	Maturity Year	10 Years
(iii)	Coupon rate	10%
(iv)	Coupon Amount	₹ 1,000 × 10% = ₹ 100 p.a.
(v)	B_0 / Value of the Bond as on Today/ Current Market Price/Issue Price/ Net Proceeds	₹ 950
(vi)	Yield to Maturity/ Kd / Discount Rate / Required return of investor / Cost of debt / Expected Return/ Opportunity Cost / Market Rate of Interest	12%
(vii)	Redemption Value/ Maturity Value	₹ 1,200

Note :

(i) Coupon Rate is used to calculate Interest Amount.
(ii) Face Value is always used to calculate Interest Amount.
(iii) If Maturity Value is not given, then it is assumed to be equal to Face Value.
(iv) If Face Value is not given, then it is assumed to be ₹ 100 or ₹ 1000 according to the Question.
(v) If Maturity Year is not given, then it is assumed to be equal to infinity.

LOS 3 : Valuation of Straight Bond / Plain Vanilla Bond

Straight Coupon Bonds are those bonds which pay equal amount of interest and repay principal amount on Maturity.

Step 1: Estimates the cash flows over the Life of the bond.

Step 2: Determine the appropriate discount rate.

Step 3: Calculate the present value of the estimated cash flow using appropriate discount rate.

$$B_0 = \frac{\text{Interest}}{(1+\text{YTM})^1} + \frac{\text{Interest}}{(1+\text{YTM})^2} + \ldots\ldots\ldots\ldots\ldots + \frac{\text{Interest}}{(1+\text{YTM})^n} + \frac{\text{Maturity value or Par value}}{(1+\text{YTM})^n}$$

Or

Interest × PVAF (Yield %, n year) + Maturity Value × PVF (Yield %, nth year)

n = No. of years to Maturity

LOS 4 : Coupon Rate Structures

1. **Zero – Coupon Bond (Pure Discount Securities)**
   a) They do not pay periodic interest.
   b) They pay the Par value at maturity and the interest results from the fact that Zero – Coupon Bonds are initially sold at a price below Par Value. (i.e. They are sold at a significant discount to Par Value).
2. **Step – up Notes**
   a) They have coupon rates that increase over – time at a specified rate.
   b) The increase may take place one or more times during the life cycle of the issue.
3. **Deferred – Coupon Bonds**
   a) They carry coupons, but the initial coupon payments are deferred for some period.
   b) The coupon payments accrue, at a compound rate, over the deferral period and are paid as a lump sum at the end of that period.
   c) After the initial deferment period has passed, these bonds pay regular coupon interest for the rest of the life of the issue (to maturity).
4. **Floating – Rate Securities**
   a) These are bond for which coupon interest payments over the life of security vary based on a specified reference rate.
   b) Reference Rate may be LIBOR [London Interbank Offered Rate] or EURIBOR or any other rate and then adds or subtracts a stated margin to or from that reference rate.

New coupon rate = Reference rate ± quoted margin

5. **Inflation – indexed Bond (TIPS)**

They have coupon formulas based on inflation.

E.g.: Coupon rate = 3% + annual change in CPI

LOS 5 : Valuation of Perpetual Bond/ Irredeemable Bond/ Non – Callable Bond

They are infinite bond, never redeemable, non- callable bond.

$$\text{Value of Bond} = \frac{\text{Annual Interest}}{\text{YTM}}$$

LOS 6 : Valuation of Zero-Coupon Bond

- Zero- coupon Bond has only a single payment at maturity.
- Value of Zero- Coupon Bond is simply the PV of the Par or Face Value.

$$\text{Bond value} = \frac{\text{Maturity Value}}{(1+\text{YTM})^{n}}$$

LOS 7 : Confusion regarding Coupon Rate & YTM

YTM → Required Return / Investor's Expectation / Mkt. Rate of Interest.

- YTM is always subjected to change according to Market Conditions.

Coupon Rate → Rate of Interest paid by the company.

- Coupon Rate is always constant throughout the life of the bond and it is not affected by change in market condition.
- Sometimes interest is expressed in terms of Basis Point i.e. 1% = 100 Basis Points

LOS 8 : Valuation of Semi – annual Coupon Bonds

Pay interest every six months

$$\text{a)}\ \frac{\text{YTM p.a.}}{2} \qquad \text{b)}\ \frac{\text{Coupon rate p.a}}{2} \qquad \text{c)}\ n \times 2$$

Note:

If quarterly use 4 instead of 2
If monthly use 12 instead of 2

QUESTION NO. 4C

On 31st March, 2013, the following information about Bonds is available:

Name of Security	Face Value ₹	Maturity Date	Coupon Rate	Coupon Date(s)
Zero coupon	10,000	31st March, 2023	N.A.	N.A.
T-Bill	1,00,000	20th June, 2013	N.A.	N.A.
10.71% GOI 2023	100	31st March, 2023	10.71	31st March
10 % GOI 2018	100	31st March, 2018	10.00	31st March & 30th September

Calculate:

(i) If 10 years yield is 7.5% p.a. what price the Zero Coupon Bond would fetch on 31st March, 2013?
(ii) What will be the annualized yield if the T-Bill is traded @ 98500?
(iii) If 10.71% GOI 2023 Bond having yield to maturity is 8%, what price would it fetch on April 1, 2013 (after coupon payment on 31st March)?
(iv) If 10% GOI 2018 Bond having yield to maturity is 8%, what price would it fetch on April 1, 2013 (after coupon payment on 31st March)?

LOS 9 : Valuation of Bond with Changing Coupon Rate

Coupon rate changes from one year to another year as per the terms of bond-indenture.

QUESTION NO. 5A

The Elu Co. is contemplating a debenture issue on the following terms:

Face Value	₹ 100 per debenture
Term to maturity	7 years
Coupon rate of interest:	
Years	
1-2	8% p.a.
3-4	12% p.a.
5-7	15% p.a.

The current market rate of interest on similar debentures is 15% per annum. The company proposes to price the issue so as to yield a (compounded) return of 16% per annum to the investor. Determine the issue price. Assume redemption at a premium of 5% on face value.

Present value interest factor @ 16% p.a.

Period	0	1	2	3	4	5	6	7
Factor	1.000	0.862	0.743	0.641	0.552	0.476	0.410	0.354

LOS 10: Over – Valued & Under – Valued Bonds

Case	Value	Decision
PV of MP of Bond < Actual MP of Bond	Over – Valued	Sell
PV of MP of Bond > Actual MP of Bond	Under – Valued	Buy
PV of MP of Bond = Actual MP of Bond	Correctly Valued	Either Buy/ Sell

LOS 11: Self – Amortization Bond

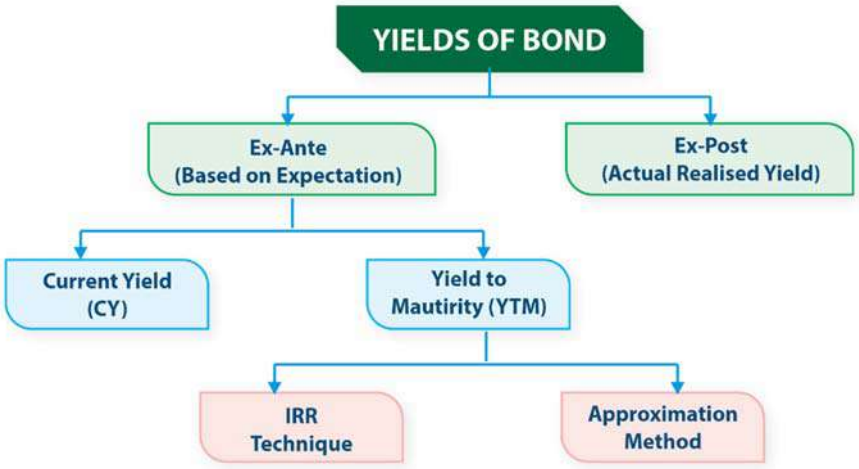
- They make periodic interest and principal payments over the life of the bond. i.e. at regular interval.
- Interest is calculated on balance amount.

LOS 12: Holding Period Return (HPR) for Bonds

$$HPR = \frac{B_1 - B_0 + I_1}{B_0}$$

$$= \frac{B_1 - B_0}{B_0} + \frac{I_1}{B_0}$$

(Capital gain Yield/ Return) (Interest Yield /Current Yield)



LOS 13 : Calculation of Current Yield/ Interest Yield

$$\text{Current Yield} = \frac{\text{Annual Cash Coupon Payment}}{\text{Bond Price or Market Price}}$$

Note: Current Yield is always calculated on per annum basis.

1. **If existing bond :-**
   B_0 = Current Market Price of Bond (1st preference)
   Or
   Present value Market Price of Bonds (2nd preference)
2. **If new bond issued :-**
   B_0 = Issue Price
   Issue Price = Face value – Discount + Premium
3. **Company Point of view :-**
   B_0 = Net Proceeds
   Net Proceeds = Face value – Discount + Premium (-) Floating Cost

LOS 14 : YTM (Yield to Maturity) / Kd / Cost of debt/ Market rate of Interest/ Market rate of return

- YTM is an annualized overall return on the bond if it is held till maturity.
- YTM is the IRR of a Bond
- It is the annualized rate of return on the investment that the investor expect (on the date of investment) to earn from the date of investment to the date of maturity. It is also referred to as required rate of return.

Alternative 1: By IRR technique.

$$B_0 = \frac{\text{Interest}}{(1+\text{YTM})^1} + \frac{\text{Interest}}{(1+\text{YTM})^2} + \ldots\ldots\ldots\ldots\ldots + \frac{\text{Interest}}{(1+\text{YTM})^n} + \frac{\text{Maturity value or Par value}}{(1+\text{YTM})^n}$$

- YTM & price contain the same information
  - If YTM given, calculate Price.

- If Price given, calculate YTM.

$$\text{YTM} = \text{Lower Rate} + \frac{\text{Lower Rate}_{NPV}}{\text{Lower Rate}_{NPV} - \text{Higher Rate}_{NPV}} \times \text{Difference in Rate}$$

Alternative 2: By approximation formula

$$\text{YTM} = \frac{\text{Interest} + \frac{\text{Maturity Value} - \text{CMP}/B_0}{n}}{\frac{\text{Maturity Value} + \text{CMP}/B_0}{2}}$$

QUESTION NO. 8E

Mr. X wants to invest ₹ 1,00,000 in the 7 years 8% bonds in the market (Face Value ₹ 100) which were issued 2 years ago.

(i) You are requested to advise him what is the maximum price for bonds to be paid in the following scenarios:
  (1) If Mr. X is expecting minimum 9% return on the bonds
  (2) If Mr. X is expecting minimum 7% return on the bonds
  (3) If the present rate of similar bonds issued is 8.25%
  (4) If the present rate of similar bonds issued is 7.75%

(ii) If the bonds are available at par and 1% is the transaction cost, what is the effective yield?

(iii) Find the number of days required to breakeven transaction cost if the bonds are available at par and 2% is the transaction cost.

LOS 15 : YTM (Yield to Maturity) of Semi-Annual Bond

$$\text{YTM per 6 months} = \frac{\text{Interest for 6 months} + \frac{\text{Maturity Value} - \text{CMP}/B_0}{n \times 2}}{\frac{\text{Maturity Value} + \text{CMP}/B_0}{2}}$$

YTM per annum = YTM of 6 month × 2

LOS 16 : YTM of a Zero – Coupon Bond

$$\text{Bond value} = \frac{Maturity\ Value}{(1 + YTM)^n}$$

- If YTM is given, calculate B_0.
- If B_0 is given, Calculate YTM.

LOS 17 : YTM of a Perpetual Bond

$$\text{Bond value} = \frac{Annual\ Interest}{YTM}$$

- If YTM is given, calculate B_0.
- If B_0 is given, Calculate YTM.

QUESTION NO. 10

Calculate Market Price of: 10% Government of India security currently quoted at ₹ 110, but interest rate is expected to go up by 1 %.

LOS 18 : Calculation of K_d in case of Floating Cost

- Floating Cost is cost associated with issue of new bonds.
  e.g. Brokerage, Commission, etc
- We should take Bond value (B_0) Net of Floating Cost.

$$K_d = \frac{\text{Interest}(1-\text{tax rate}) + \frac{\text{Maturity Value} - \text{Net Proceeds}}{n}}{\frac{\text{Maturity Value} + \text{Net Proceeds}}{2}}$$

LOS 19 : Treatment of Tax

Tax is important part for our analysis, it must be considered if it is given in question.

Two types of Tax rates are given :-

1. **Interest Tax rate/ Normal Tax Rate**

   We should take Interest Net of Tax i.e. Interest Amount (1 – Tax)

2. **Capital Gain Tax rate**

   Take Maturity value after Capital Gain Tax i.e. Maturity Value – Capital Gain Tax Amount

   Maturity value – (Maturity value – B_0) × Capital gain tax rate

$$YTM = \frac{\text{Interest}(1-\text{Tax rate}) + \frac{\text{MV net of CG Tax} - B_0}{n}}{\frac{\text{MV net of CG Tax} + B_0}{2}}$$

LOS 20 : Yield to call (YTC) & Yield to Put (YTP)

1. Yield to Call

Callable Bond : When company call its bond or Re-purchase its bond prior to the date of Maturity.
Call Price: Price at which Bond will call by the Company.
Call Date: Date on which Bond is called by the Company prior to Maturity.
n : No. of Years upto Call Date.

$$YTC = \frac{\text{Interest} + \frac{\text{Call Price} - B_0}{n}}{\frac{\text{Call Price} + B_0}{2}}$$

2. Yield to Put

Puttable Bond: When investor sell their bonds prior to the date of maturity to the company.
Put Price: Price at which Bond will put/ Sell to the Company.
Put Date: Date on which Bond is sold by the investor prior to Maturity.

n : No. of years upto Put Date.

$$YTP = \frac{\text{Interest} + \frac{\text{Put Price} - B_0}{n}}{\frac{\text{Put Price} + B_0}{2}}$$

LOS 21 : Yield to worst

- It is the lowest yield between YTM, YTC, YTP, Yield to first call.
- Yield to worst is lowest among all.

LOS 22 : Return Calculation

- When bonds are purchased and sold within time frame.

QUESTION NO. 15

Vipin purchased at par a bond with a Face Value of ₹ 1,000. The bond had five year to maturity and a 10% coupon rate. The bond was called two years later for a price of ₹ 1,200 after making its second annual interest payment. Vipin then reinvested the proceeds in a bond selling at its Face Value of ₹ 1,000 with three years to maturity and a 7% coupon rate. What was Vipin's actual YTM over the five-year period?

LOS 23 : Conversion Value/ Stock Value of Bond

- Converted into equity shares after certain period.
- Conversion Ratio = No. of share Received per Convertible Bond
- When **Conversion Value > Bond value,** option can be exercised otherwise not.

$$\text{Conversion Value} = \text{No. of equity shares issued} \times \text{MPS at the time of Conversion}$$

QUESTION NO. 16A

There is conversion option on an 8% convertible debenture, if unconverted it is redeemable at par in 10 years' time; conversion will be for 20 ordinary shares, the current share price being 3.70. The current required return on unconvertible debentures with a 10-year maturity is 12%. Find the straight debt value i.e. value obtained when securities are not converted and conversion value of this security as on today .Should the bond be converted as on today.

LOS 24 : Credit Rating Requirement

- As per SEBI regulation, no public or right issue of debt/bond instruments shall be made unless credit rating from credit rating agency has been obtained and disclosed in the offer document.
- Rating is based on the track record, financial statement, profitability ratios, debt – servicing capacity ratios, credit worthiness & risk associated with the company.
- Higher rated Bonds means low risk and a lower rated bond means high risk.
- Higher the risk higher will be the expectation and higher will be the discount rate.

QUESTION NO. 17

Based on the credit rating of bonds Mr. Mohan has decided to apply the following discount rates for valuing bonds:

Credit rating	Discount rates
AAA	364-day T-bill rate + 3% spread
AA	AAA + 2% spread
A	AAA + 3% spread

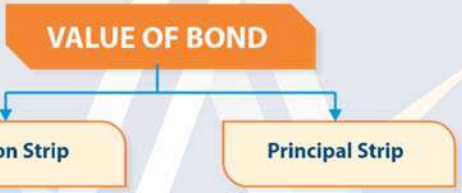
He is considering to invest in a AA rated, ₹ 1000 face value bond currently selling at ₹ 1025.86. The bond has five years to maturity and the coupon rate on the bond is 15% p.a. payable annually. The next interest payment is due one year from today and the bond is redeemable at par. (Assume the 364-day T-bill rate to be 9%).

a) You are required to calculate the intrinsic value of the bond for Mr. Mohan. Should he invest in the bond?

b) Calculate the current yield and yield to maturity of the bond.

LOS 25 : Strips (Separate Trading of Registered Interest & Principal Securities) Program

Under this, Strip the coupons from the principal, repackage the cash flows and sell them separately as Zero – Coupon Bonds, at discount.



$$\text{Value of Bond} = \underbrace{\frac{\text{Interest}}{(1+k_d)^1} + \frac{\text{Interest}}{(1+k_d)^2} + \ldots\ldots\ldots\ldots\ldots + \frac{\text{Interest}}{(1+k_d)^n}}_{\text{Coupon Strips}} + \underbrace{\frac{\text{Maturity value}}{(1+k_d)^n}}_{\text{Principal Strips}}$$

LOS 26 : Relationship between Coupon Rate & YTM

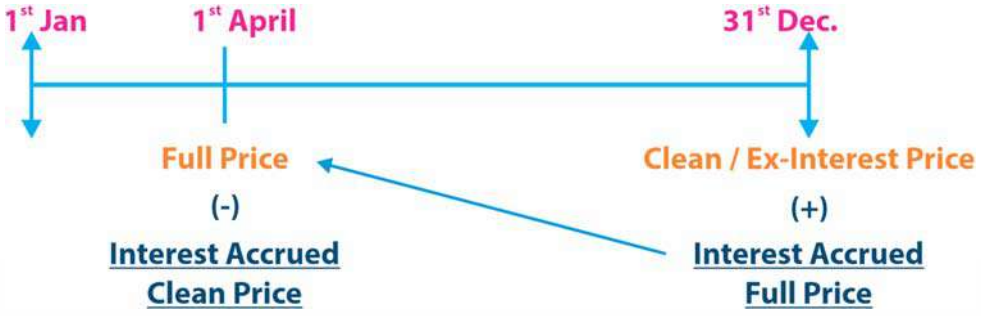
Bonding Selling At	
Par	Coupon Rate = Yield to Maturity
Discount	Coupon Rate < Yield to Maturity
Premium	Coupon Rate > Yield to Maturity

LOS 27 : Cum Interest & Ex-interest Bond Value

- When Bond value include amount of interest it is known as Cum-Interest Bond Value, other -wise not.
- If question is Silent, we will always assume ex-interest.
- Assume value of Bond (B_0) as ex – interest.
- If it is given Cum-Interest then deduct Interest and proceeds your calculations.

Full Price = Clean Price + Interest accrued
Or
Cum - Interest Price = Ex – Interest Price + Interest Accrued

Valuation of a Bond between two coupon dates



QUESTION NO. 20C

MP Ltd. issued a new series of bonds on January 1,2000. The bonds were sold at par (₹ 1,000), having a coupon rate 10% p.a. and mature on 31st December, 2015. Coupon payments are made semi-annually on June 30th and December 31st each year. Assume that you purchased an outstanding MP Ltd. Bond on 1st March, 2008 when the going interest rate was 12%.

Required:

a) What was the YTM of MP Ltd. Bonds as on January 1, 2000?

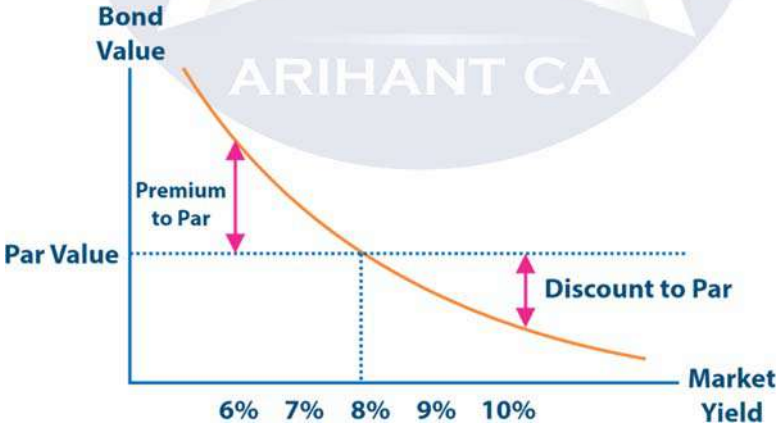
b) What amount you should pay to complete the transaction for purchasing the bond on 1st March 2008 ? Of that amount how much should be accrued interest and how much would represent bonds basic value.

LOS 28 : Relationship between Bond Value & YTM

- When the coupon rate on a bond is equal to its market yield, the bond will trade at its par value.
- If yield required in the market subsequently rises, the price of the bond will fall & it will trade at a discount.
- If required yield falls, the bond price will increase and bond will trade at a premium.

Crux:

- If YTM increases, bond value decreases & vice-versa, other things remaining same.
- YTM & Bond value have inverse relationship.



Convexity of a Bond

- However, this relationship is not a straight line relationship but it is convex to the origin.
- So, we find that price rise is greater than price fall, we call it positive convexity (i.e. % rise is greater than % fall)

LOS 29 : Value of the Bond at the end of each Year

$$B_0 = \frac{B_1 + I_1}{(1+YTM)^1}$$

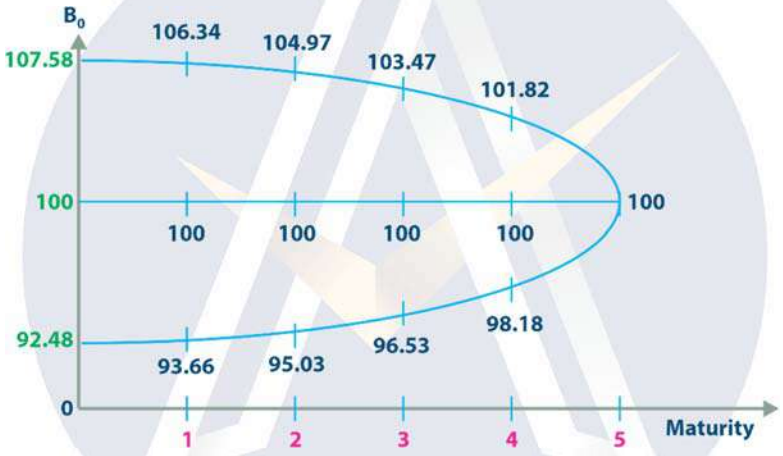
$$B_1 = \frac{B_2 + I_2}{(1+YTM)^1}$$

.
.
.

So on

LOS 30 : Relationship between Bond Value & Maturity

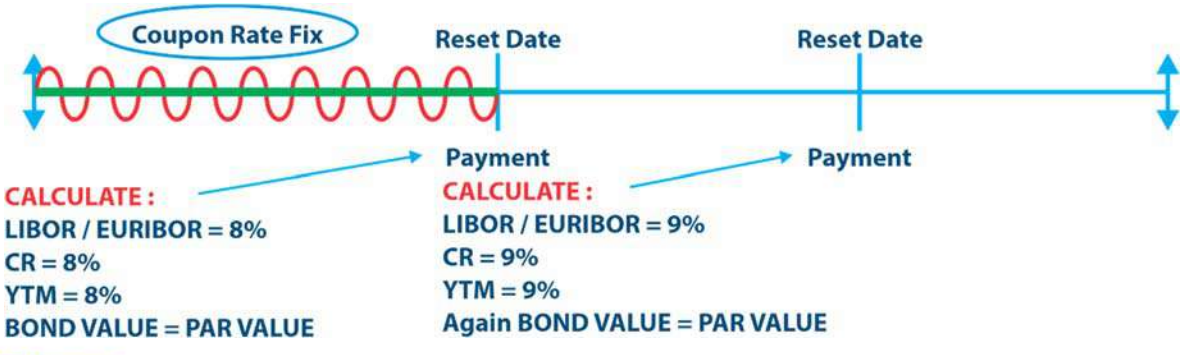
- Prior to Maturity, a bond can be selling at significant discount or premium to Par value.
- Regardless of its required yield, the price will converge to par value as Maturity approaches.
- Value of premium bond decrease to par value , value of Discount bond increases to Par value.
- Premium and discount vanishes.



LOS 31 : Floating Rate Bonds

- Floating Rate Bonds are those bonds where coupon rate is decided according to the Reference rate (Market Interest Rate).
- Coupon Rate should be changed with the change in Reference rate (Market Interest Rate).
- In this case

Coupon Rate = YTM



LOS 32 : Duration of a Bond (Macaulay Duration)

- Duration of the bond is a weighted average of the time (in years) until each cash flow will be received i.e. our initial investment is fully recovered.
- Duration is a measurement of how long in years it takes for the price of a bond to be repaid by its internal cash flows.
- Duration of bond will always be less than or equal to maturity years.

Duration =

$$\frac{1 \times \frac{Interest}{(1+YTM)^1} + 2 \times \frac{Interest}{(1+YTM)^2} + \ldots\ldots + n \times \frac{Interest}{(1+YTM)^n} + n \times \frac{Maturity\ value}{(1+YTM)^n}}{CMP/B_0}$$

QUESTION NO. 25A

Consider a bond which has the following features:

Face Value	₹ 100	Coupon (interest rate)	15% payable annually
Years the maturity	6 years	Redemption Value	100
Current Market Price	₹ 89.50	Yield to Maturity	18%

What is the duration of bond?

QUESTION NO. 25C

Find the current market price of bond having face value ₹ 1,00,000 redeemable after 6 year maturity with YTM at 16% payable annually and duration 4.3202 years

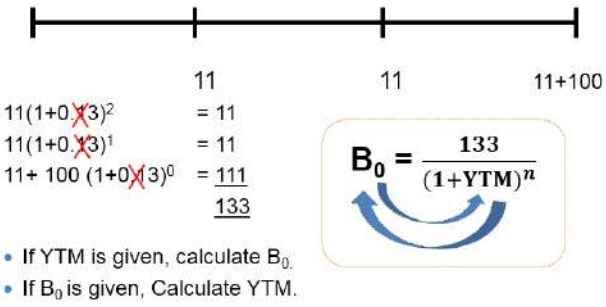
LOS 33 : Duration of a Zero - Coupon Bond

Duration of a Zero Coupon Bond will always be equal to its Maturity Years

LOS 34 : Relationship between Duration of Bond & YTM

- If YTM increases, Bond Value decreases so duration of the bond decreases (recovery is less) & vice versa.
- Higher the YTM, lower will be duration of a bond. Lower the YTM, higher will be duration of a bond, other things remaining constant.

LOS 35 : Calculation of yield when Coupon Payment is not available for Re-Investment



QUESTION NO. 28B

XL Ispat Ltd. has made an issue of 14 per cent non-convertible debentures on January 1, 2007. These debentures have a face value of ₹ 100 and is currently traded in the market at a price of ₹ 90.

Interest on these NCDs will be paid through post-dated cheques dated June 30 and December 31. Interest payments for the first 3 years will be paid in advance through post-dated cheques while for the last 2 years post-dated cheques will be issued at the third year. The bond is redeemable at par on December 31, 2011 at the end of 5 years.

Required :

(i) Estimate the current yield and YTM of the bond.

(ii) Calculate the duration of the NCD.

(i) Assuming that intermediate coupon payments are, not available for reinvestment calculate the realised yield on the NCD.

QUESTION NO. 28C

Mr. X purchases a 5 year 8.5% Coupon Bond for a price of ₹907.60 (Face Value ₹1000) that has a YTM of 11%. You are required to compute reinvested interest amount on this bond.

LOS 36 : Modified Duration/ Sensitivity/ Volatility/ Effective Duration

- Volatility measures the sensitivity of interest rate to bond prices.
- Duration of a bond can be used to estimate the price sensitivity. It can be calculated through below formula.
- Modified duration will always be lower than Macaulay's Duration.
- Volatility measures the % change in the bond value with 1% change in YTM.

Example:

If Volatility is 5%, it means if YTM increases by 1% bond value will decrease by 5% or vice versa.

Method 1:

$$\text{Modified Duration} = \frac{\text{Macaulay Duration}}{1 + \text{YTM}}$$

Method 2:

$$\text{Effective Duration} = \frac{BV_{-\Delta Y} - BV_{+\Delta Y}}{2 \times BV_0 \times \Delta Y}$$

Convexity Adjustment

As mentioned above duration is a good approximation of the percentage of price change for a small change in interest rate. However, the change cannot be estimated so accurately of convexity effect as duration base estimation assumes a linear relationship.

This estimation can be improved by adjustment on account of 'convexity'. The formula for convexity is as follows:

$$C^* \times (\Delta y)^2 \times 100$$

Δy = Change in Yield

$$C^* = \frac{V_+ + V_- - 2V_0}{2V_0(\Delta^2)}$$

V0 = Initial Price

V+ = price of Bond if yield increases by Δy

V- = price of Bond if yield decreases by Δy

QUESTION NO. 29C

The following data are available for a bond:
Face Value ₹ 10,000 to be redeemed at par on maturity
Coupon rate 8.5 per cent per annum
Years to Maturity 5 years
Yield to Maturity (YTM) 10 per cent You are required to calculate:

(i) Current market price of the Bond,
(ii) Macaulay's Duration,
(iii) Volatility of the Bond,
(iv) Convexity of the Bond,
(v) Expected market price, if there is a decrease in the YTM by 200 basis points
  (a) By Macaulay's Duration based estimate
  (b) By Intrinsic Value Method.

Given

Years	1	2	3	4	5
PVIF (10%, n)	0.909	0.826	0.751	0.683	0.621
PVIF (8%, n)	0.926	0.857	0.794	0.735	0.681

LOS 37 : Ratios related to Convertible Bond

1. Conversion Premium/ Premium over Conversion Value

= Market value of Convertible bond
(-)
CV (No. of Shares × MPS)

$$\text{\% Conversion Premium} = \frac{\text{Conversion Premium}}{\text{Conversion Value}}$$

2. Conversion Premium per share $= \frac{Conversion\ Premium}{Conversion\ Ratio}$

3. Conversion Parity Price/ No Gain No Loss / Market Conversion Price

When the market value of convertible bond = Conversion Value.

$$= \frac{\text{Market value of Convertible bond}}{\text{No.of equity share issued on Conversion}}$$

OR

= Current MPS + Conversion Premium per share

4. Premium Pay Back Period or Break Even Period of Convertible Bond

It is a time period, when bond would be converted into equity share so that the loss on conversion would be set-off by income from interest.

$$\text{Break Even Period} = \frac{\text{Conversion Premium}}{\text{Favourable Income Differencial}}$$

OR

$$= \frac{\text{Market Price of Bond} - \text{Conversion Value}}{\text{Interest on Bond} - \text{Dividend on Share}}$$

5. Downside Risk or Premium over Non-Convertible Bond

Downside Risk reflects the extent of decline in market value of convertible bonds at which conversion option become worthless.

= Market value of Convertible bond

(-)

Market value of Non- Convertible bond

$$\text{\% Downside Risk/ \% Price Decline} = \frac{\text{Downside Risk}}{\text{Market value of Non-convertible bond}}$$

6. Premium Over Investment Value of Non-Convertible bond / MV of NCB :

$$= \frac{\text{Market Price of CB} - \text{Investment Value / MV of Non-Convertible Bond}}{\text{Investment Value / MV of Non-Convertible Bond}}$$

7. Floor Value : Floor Value is the maximum of :

a) Conversion Value
b) Market Value of Non-Convertible Bond.

Note: Market Value of Convertible Bond (Assume 5 Years)

$$= \frac{\text{Interest}}{(1+\text{YTM})^1} + \frac{\text{Interest}}{(1+\text{YTM})^2} + \ldots\ldots\ldots\ldots\ldots + \frac{\text{Interest}}{(1+\text{YTM})^5} + \frac{\text{Conversion Value } (CV_5)}{(1+\text{YTM})^5}$$

CV_5 = MPS at the end of Year 5 × No. of Shares.

QUESTION NO. 30D

A Ltd. has in issue 9% bonds which are redeemable at their par value of £100 in five years' time. Alternatively, each bond may be converted on that date into 20 ordinary shares of the company. The current ordinary share price of A Ltd. is £4.45 and this is expected to grow at a rate of 6.5% per year for the foreseeable future. A Ltd. has a cost of debt of 7% per year. Required:

Calculate the following current values for each £ 100 convertible bond:

a) market value;

b) floor value;
c) Conversion premium.

QUESTION NO. 30G

The following data is related to 8.5% Fully Convertible (into Equity shares) Debentures issued by JAC Ltd. at ₹ 1000.

Market Price of Debenture	₹ 900
Conversion Ratio	30
Straight Value of Debenture	₹ 700
Market Price of Equity share on the date of Conversion	₹ 25
Expected Dividend Per Share	₹ 1

You are required to calculate:

a) Conversion Value of Debenture
b) Market Conversion Price
c) Conversion Premium per share
d) Ratio of Conversion Premium
e) Premium over Straight Value of Debenture
f) Favourable income differential per share
g) Premium pay back period

LOS 38: Callable Bond

Those bonds which can be called before the date of Maturity.

Step 1 : Calculate Net Initial Outflow.
Step 2 : Calculate Tax Saving on Call Premium & Unamortized Issue Cost.
Step 3 : Calculate Annual Saving on Cash Outflow.
Step 4 : Calculation of Overlapping Interest
Step 5 : Calculate Present Value of Total Net Savings by replacing Outstanding Bonds with New Bonds.

QUESTION NO. 31B

T is contemplating calling ₹ 3 crores of 30 years, ₹ 1,000 bond issued 5 years ago with a coupon interest rate of 14%. The bonds have a call price of ₹1,140 and had initially collected proceeds of ₹ 2.91 crores due to a discount of ₹ 30 per bond. The initial floating cost was ₹ 3,60,000. The company intends to sell ₹ 3 crores of 12% coupon rates, 25 years bonds to raise funds for retiring the old bonds. It proposes to sell the new bonds at their par value of ₹ 1,000. The estimated floatation cost is ₹ 4,00,000. The company is paying 40% tax and its after cost of debt is 8%. As the new bonds must first be sold and their proceeds, then used to retire old bonds, the company expects a two months period of overlapping interest during which interest must be paid on both the old and new bonds. What is the feasibility of refunding bonds?

LOS 39: Spot Rate

- Yield to maturity is a single discount rate that makes the present value of the bond's promised cash flow equal to its Market Price.
- The appropriate discount rates for individual future payments are called Spot Rate.
- Discount each cash flow using a discount rate i.e. specific to the maturity of each cash flow.

Example

Consider an annual-pay bond with a 10% coupon rate and three years of maturity. This bond will make three payments. For a ₹ 1000 bond these payments will be ₹ 100 in one year, ₹ 100 at the end of two years, and ₹100 three years from now. Suppose we are given the following spot rates:
1 year = 8%
2 year = 9%

3 year = 10%

Solution:

Discounting each promised payment by its corresponding spot rate, we can value the bond as:

$$= \frac{100}{(1.08)^1} + \frac{100}{(1.09)^2} + \frac{1100}{(1.10)^3} = 1003.21$$

LOS 40: Relationship between Forward Rate and Spot Rate

Forward Rate is a borrowing/ landing rate for a loan to be made at some future date.

${}_1f_0$ = Spot Rate or Current YTM (rate of 1 year loan)

${}_1f_1$ = Rate for a 1 year loan, one year from now

${}_1f_2$ = Rate for a 1 year loan to be made two years from now

Relationship:

$(1+S_1)^1 = (1 + {}_1f_0)$

$(1+S_2)^2 = (1 + {}_1f_0)(1 + {}_1f_1)$

Or $S_2 = \{(1 + {}_1f_0)(1 + {}_1f_1)\}^{1/2} - 1$

$(1 + S_3)^3 = (1+{}_1f_0)(1+ {}_1f_1)(1 + {}_1f_2)$

Or $S_3 = \{(1 + {}_1f_0)(1 + {}_1f_1)(1 + {}_1f_2)\}^{1/3} - 1$

Example:

Using forward rates:

The current 1-year rate (${}_1f_0$) is 4%

The 1-year forward rate for lending from time =1 to time=2 is ${}_1f_1$ =5%, and

The 1-year forward rate for lending from time =2 to time =3 is ${}_1f_2$ =6%.

Calculate value of a 3-year annual-pay bond with 5% coupon and a par value of ₹ 1000.

Solution:

$$\text{Bond value} = \frac{50}{(1+{}_1f_0)} + \frac{50}{(1+{}_1f_0)(1+{}_1f_1)} + \frac{1050}{(1+{}_1f_0)(1+{}_1f_1)(1+{}_1f_2)}$$

$$= \frac{50}{(1.04)} + \frac{50}{(1.04)(1.05)} + \frac{1050}{(1.04)(1.05)(1.06)} = ₹\ 1000.98$$

QUESTION NO. 32A

ABC Ltd issued 9%, 5yr Bond of ₹ 1000/- each having a maturity of 3 Years. The present rate of interest is 12% for one year tenure. It is expected that Forward rate of interest for one year tenure is going to fall by 75 basis points and further by 50 basis points for every next year in future for the same tenure. This bond has a Beta value of 1.02 and is more popular in the market due to less credit risk.

Calculate:

a) Intrinsic Value of the Bond.

b) Expected price of Bond in the market.

QUESTION NO. 32C

Consider the following data for Government securities:

Face Value (₹)	Interest Rate	Maturity (Year)	Current Price (₹)
1,00,000	0%	1	91,000
1,00,000	10.5%	2	99,000
1,00,000	11.0%	3	99,500
1,00,000	11.5%	4	99,900

Calculate the forward interest rates.

QUESTION NO. 32D

The following is the Yield structure of AAA rated debenture:

Period (or Maturity)	Yield (%)
3 months	8.5%
6 months	9.25
1 year	10.50
2 years	11.25
3 years and above	12.00

a) Based on the expectation theory calculate the implicit one-year forward rates in year 2 and year 3.

b) If the interest rate increases by 50 basis points, what will be the percentage change in the price of the bond having a maturity of 5 years? Assume that the bond is fairly priced at the moment at ₹ 1,000.

QUESTION NO. 32F

Following are the yields on Zero Coupon Bonds (ZCB) having a face value of ₹ 1,000

Maturity (Years)	Yield to Maturity (YTM)
1	10%
2	11%
3	12%

Assume that the term structure of interest rate will remain the same.

You are required to

(i) Calculate the implied one year forward rates

(ii) Expected Yield to Maturity and prices of one year and two year Zero Coupon Bonds at the end of the first year.

LOS 41 : Duration of a Portfolio

It is simply the weighted average of the durations of the individual securities in the Portfolio.

$$\text{Portfolio Duration} = W_1D_1 + W_2D_2 + W_3D_3 + \text{----------} + W_nD_n$$

$$W_i = \frac{\text{Market value of bond I}}{\text{Market value of Portfolio}}$$

Di = Duration of bond (i)

N = No. Of bonds in the Portfolio

Note :

- Other factors are constant, Long term bonds are more volatile than Short term bonds.
- Other factors are constant, Lower coupon bonds are more volatile than Higher coupon bonds.
- Other factors are constant, Lower Yield bonds are more volatile than Higher Yield bonds.

LOS 42 : Passive Portfolio Management (Bond Immunization)

- Bond immunization is an investment strategy used to minimize the interest rate risk of bond investments by adjusting the portfolio duration to match the investor's investment time horizon.
- To immunize a bond portfolio, you need to know the duration of the bonds in the portfolio and adjust the portfolio so that the portfolio's duration equals the investment time horizon.
- Changes to interest rates actually affect two parts of a bond's value. One of them is a change in the bond's price, or price effect. When interest rates change before the bond matures, the bond's final value changes, too. An increase in interest rates means new bond issues offer higher earnings, so the prices of older bonds decline on the secondary market.

- Interest rate fluctuations also affect a bond's reinvestment risk. When interest rates rise, a bond's coupon may be reinvested at a higher rate. When they decrease, bond coupons can only be reinvested at the new, lower rates.
- Interest rate changes have opposite effects on a bond's price and reinvestment opportunities. While an increase in rates hurts a bond's price, it helps the bond's reinvestment rate. The goal of immunization is to offset these two changes to an investor's bond value, leaving its worth unchanged.
- **A portfolio is immunized when its duration equals the investor's time horizon**. At this point, any changes to interest rates will affect both price and reinvestment at the same rate, keeping the portfolio's rate of return the same. Maintaining an immunized portfolio means rebalancing the portfolio's average duration every time interest rates change, so that the average duration continues to equal the investor's time horizon.

QUESTION NO. 33A

Mr. A will need ₹ 1,00,000 after two years for which he wants to make one time necessary investment now. He has a choice of two types of bonds. Their details are as below :

	Bond X	Bond Y
Face value	₹ 1,000	₹ 1,000
Coupon	7% payable annually	8% payable annually
Years to maturity	1	4
Current price	₹ 972.73	₹ 936.52
Current yield	10%	10%

Advice Mr. A whether he should invest all his money in one type of bond or he should buy both the bonds and, if so in which quantity?

Assume that there will not be any call risk or default risk.

QUESTION NO. 33B

The following data are available for three bonds A, B and C. These bonds are used by a bond portfolio manager to fund an outflow scheduled in 6 years. Current yield is 9%. All bonds have face value of ₹100 each and will be redeemed at par. Interest is payable annually.

Bond	Maturity (Years)	Coupon rate
A	10	10%
B	8	11%
C	5	9%

(i) Calculate the duration of each bond.

(ii) The bond portfolio manager has been asked to keep 45% of the portfolio money in Bond A. Calculate the percentage amount to be invested in bonds B and C that need to be purchased to immunise the portfolio.

(iii) After the portfolio has been formulated, an interest rate change occurs, increasing the yield to 11%. The new duration of these bonds are: Bond A = 7.15 Years, Bond B = 6.03 Years and Bond C = 4.27 years.

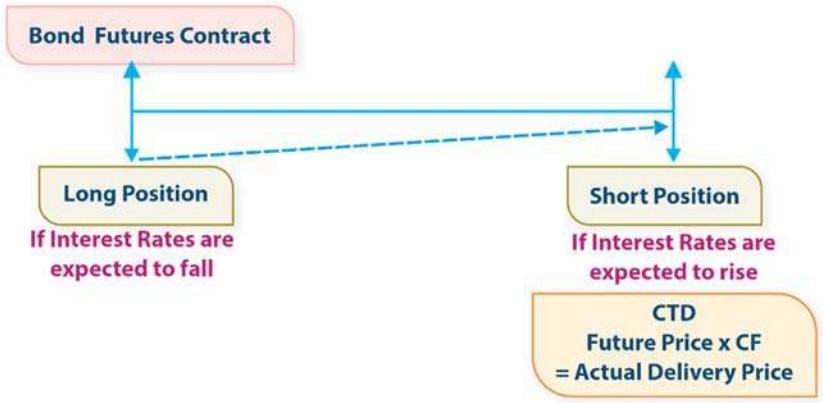
Is the portfolio still immunized? Why or why not?

(iv) Determine the new percentage of B and C bonds that are needed to immunize the portfolio. Bond A remaining at 45% of the portfolio.

Present values be used as follows :

Present Values	t1	t2	t3	t4	t5
PVIF0.09, t	0.917	0.842	0.772	0.708	0.650
	t6	**t7**	**t8**	**t9**	**t10**
PVIF0.09, t	0.596	0.547	0.502	0.460	0.4224

LOS 43: Hedging Interest Rate Risk using Bond Futures



Profit of seller of futures

= (Futures Settlement Price x Conversion factor) – Quoted Spot Price of Deliverable Bond

Loss of Seller of futures

= Quoted Spot Price of deliverable bond – (Futures Settlement Price x Conversion factor)

An interest rate future is a contract between the buyer and seller agreeing to the future delivery of any interest-bearing asset. The interest rate future allows the buyer and seller to lock in the price of the interest-bearing asset for a future date.

Interest rate futures are used to hedge against the risk that interest rates will move in an adverse direction, causing a cost to the company.

For example, borrowers face the risk of interest rates rising. Futures use the inverse relationship between interest rates and bond prices to hedge against the risk of rising interest rates.

A borrower will enter to sell a future today. Then if interest rates rise in the future, the value of the future will fall (as it is linked to the underlying asset, bond prices), and hence a profit can be made when closing out of the future (i.e. buying the future).

Bonds form the underlying instruments, not the interest rate. Further, IRF, settlement is done at two levels:

- Mark-to-Market settlement done on a daily basis and
- physical delivery which happens on any day in the expiry month.

Final settlement can happen only on the expiry date. In IRF following are two important terms:

a) **Conversion factor**: All the deliverable bonds have different maturities and coupon rates. To make them comparable to each other, RBI introduced Conversion Factor.
(Conversion Factor) x (futures price) = actual delivery price for a given deliverable bond.

b) **Cheapest to Deliver (CTD** : It is called CTD bond because it is the least expensive bond in the basket of deliverable bonds.

Profit & Loss = the difference between cost of acquiring the bonds for delivery and the price received by delivering the acquired bond.

QUESTION NO. 34

In March 2020, XYZ Bank sold some 7% Interest Rate Futures underlying Notional 7.50% Coupon Bonds. The exchange provides following details of eligible securities that can be delivered:

Security	Quoted Price of Bonds	Conversion Factor
7.96 GOI 2023	1037.40	1.0370
6.55 GOI 2025	926.40	0.9060
6.80 GOI 2029	877.50	0.9195
6.85 GOI 2026	972.30	0.9643
8.44 GOI 2027	1146.30	1.1734
8.85 GOI 2028	1201.70	1.2428

Recommend the Security that should be delivered by the XYZ Bank if Future Settlement Price is 1000.

Notes