

$$\begin{aligned}\text{Income per day} &= ₹ 1,00,000 \times 8\% = ₹ 8,000 \\ &= \frac{8,000}{365} = 21.92\end{aligned}$$

$$\text{No. of days} = \frac{2,000}{₹ 21.92} = 91 \text{ days}$$

DIRTY PRICE & CLEAN PRICE**Question – 11**

MP Ltd. issued a new series of bonds on January 1, 2010. The bonds were sold at par (₹ 1,000), having a coupon rate 10% p.a. and mature on 31st December, 2025. Coupon payments are made semiannually on June 30th and December 31st each year. Assume that you purchase an outstanding MP Ltd. bond on 1st March, 2018 when the going interest rate was 12%. Required:

- (i) What was the YTM of MP Ltd. bonds as on January 1, 2010?
- (ii) What amount you should pay to complete the transaction? Of that amount how much should be accrued interest and how much would represent bonds basic value.

Solution:**(i) YTM as (01/01/2010)**

$$\text{YTM} = \frac{100}{1,000} \times 100 = 10\%$$

or

$$\begin{aligned}\text{YTM} &= \frac{₹ 50 + \left(\frac{1,000 - 1,000}{32} \right)}{\frac{1,000 + 1,000}{2}} \times 100 \\ &= \frac{₹ 50}{1,000} \times 100 \\ &= 5\% \times \frac{12}{6} = 10\%\end{aligned}$$

(ii) Full Price (Dirty Price)

Bond price as on 30/06/18

$$\begin{aligned}
&= (\text{₹ } 50 \times \text{PVAF}, 6\%, 15) + (1,000 \times \text{PVF}, 6\%, 15) \\
&= (\text{₹ } 50 \times 9.712) + (1,000 \times 0.417) \\
&= \text{₹ } 902.60 \\
&= \text{₹ } 902.60 + 50 = \text{₹ } 952.60
\end{aligned}$$

Bond price as on 01/03/18

$$\text{Full Price} = \frac{952.60}{\left[1 + 0.12 \times \frac{4}{12}\right]} = \text{₹ } 915.96$$

$$\text{Accrued Interest} = \left(\text{₹ } 1,000 \times 10\% \times \frac{2}{12}\right) = 16.67$$

$$\text{Bond Basic Value} = \text{₹ } 915.96 - 16.67 = \text{₹ } 899.29$$

(III) BOND RISK**Question – 12**

The following data is available for a bond:

Face Value	₹ 1,000
Coupon Rate	11%
Years to Maturity	6
Redemption Value	₹ 1,000
Yield to Maturity	15%

(Round-off your answers to 3 decimals)

Calculate the following in respect of the bond:

- Current Market Price.
- Duration of the Bond.
- Volatility of the Bond.
- Expected market price if increase in required yield is by 100 basis points.
- Expected market price if decrease in required yield is by 75 basis points.

Solution:

(i) & (ii) Current Market Price & Duration of the Bond

Year	CF	YTM (15%)	P.V.	Weights	W × Year
1	110	0.870	95.70	0.113	0.113
2	110	0.756	83.16	0.098	0.196
3	110	0.658	72.38	0.085	0.255
4	110	0.572	62.92	0.074	0.296
5	110	0.497	54.67	0.064	0.32
6	1,110	0.432	479.52	0.565	3.39
		CMP	848.35	Duration	4.570

(iii) Volatility of Bond

$$\begin{aligned}\text{Volatility} &= \frac{D}{1 + \text{YTM}} \\ &= \frac{4.570}{1.15} = 3.974\end{aligned}$$

(iv) If Yield Increases by 100 BP

$$\begin{aligned}\text{Effect} &= - \text{MD} \times \frac{\text{BP}}{100} \\ &= - 3.974 \times \frac{100}{100} \\ &= - 3.974\% \\ \text{Bond Price} &= 848.35 - 3.974\% \\ &= ₹ 814.64\end{aligned}$$

(v) Yield Decreases by 75 BP

$$\begin{aligned}\text{Effective Duration} &= - 3.974 \times \frac{-75}{100} \\ &= 2.9805\% \\ \text{Bond Price} &= 848.35 + 2.9805\% \\ &= ₹ 873.64\end{aligned}$$

Question – 13

Find the current market price of a bond having face value ₹ 1,00,000 redeemable after 6 year maturity with YTM at 16% payable annually and duration 4.3202 years. Given $1.16^6 = 2.4364$.

Solution:

Let assume interest amount be x

Year	CF	PVF (16%)	PVCF	Year × PV
1	x	0.862	0.862 x	0.862 x
2	x	0.743	0.743 x	1.486 x
3	x	0.641	0.641 x	1.923 x
4	x	0.552	0.552 x	2.208 x
5	x	0.476	0.472 x	2.380 x
6	1,00,000 + x	0.410	0.410 x + 41,000	2.480 x + 2,46,000
			3.684 x + 41,000	11.319 x + 2,46,000

$$4.3202 = \frac{11.319 x + 2,46,000}{3.684 x + 41,000}$$

$$15.9156 x + 1,77,128 = 11.319 x + 2,46,000$$

$$4.5966 x = 68,872$$

$$x = \frac{68,872}{4.5966} = 14,983$$

$$\text{Coupon (\%)} = \frac{14,983}{1,00,000} \times 100 = 14.98\% \text{ i.e. } 15\%$$

$$\begin{aligned} \text{CMP} &= (15,000 \times \text{PVAF}, 16\%, 6) + (1,00,000 \times \text{PVF}, 16\%) \\ &= (15,000 \times 3.685) + (1,00,000 \times 0.410) \\ &= ₹ 96,275 \end{aligned}$$

Question – 14

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 31st. 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.
- (iii) Assuming that intermediate coupon payments are, not available for reinvestment calculate the realized yield on the NCD.

Solution:

(i) Current Yield

$$\begin{aligned}\text{Current Yield} &= \frac{I}{\text{CMP}} \times 100 \times \frac{12}{6} \\ &= \frac{\text{₹ } 7}{90} \times 100 \times \frac{12}{6} \\ &= 15.55\%\end{aligned}$$

$$\begin{aligned}\text{YTM} &= \frac{I + \left(\frac{F-P}{n}\right)}{\frac{F+P}{n}} \times 100 \\ &= \frac{\text{₹ } 7 + \left(\frac{100-90}{10}\right)}{\frac{100+90}{2}} = 8.42\% \\ &= 8.42 \times \frac{12}{6} = 16.84\% \text{ p.a.}\end{aligned}$$

(ii) Duration of NCD

Year	CF	YTM (8.42%)	PV	Weights	W × Year
1	7	0.922	6.454	0.071	0.071
2	7	0.851	5.957	0.066	0.132
3	7	0.785	5.495	0.061	0.183

4	7	0.724	5.068	0.056	0.224
5	7	0.667	4.669	0.051	0.255
6	7	0.616	4.312	0.047	0.282
7	7	0.568	3.976	0.044	0.308
8	7	0.524	3.668	0.040	0.320
9	7	0.483	3.381	0.037	0.333
10	107	0.446	47.722	0.526	5.260
			₹ 90.7		7.368

$$\text{Duration} = \frac{7.368}{2} = 3.684 \text{ Years}$$

(iii) Realized YTM

Cash outflows = ₹ 90

Cash inflows

$$(\text{₹ } 7 \times 10) + 100 = \text{₹ } 170$$

$$90 (1 + r)^{10} = 170$$

$$r = \left[\left(\frac{170}{90} \right)^{1/10} - 1 \right] \times 100 = 6.57\%$$

$$\begin{aligned} \text{Realized YTM} &= 6.57 \times \frac{12}{6} \\ &= 13.14\% \text{ p.a.} \end{aligned}$$

Question – 15

- (a) Consider two bonds, one with 5 years to maturity and the other with 20 years to maturity. Both the bonds have a face value of ₹ 1,000 and coupon rate of 8% (with annual interest payments) and both are selling at par. Assume that the yields of both the bonds fall to 6%, whether the price of bond will increase or decrease? What percentage of this increase/decrease comes from a change in the present value of bond's principal amount and what percentage of this increase/decrease comes from a change in the present value of bond's interest payments?
- (b) Consider a bond selling at its par value of ₹ 1,000, with 6 years to maturity and a 7% coupon rate (with annual interest payment), what is bond's duration?

- (c) If the YTM of the bond in (b) above increases to 10%, how it affects the bond's duration? And why?

Solution:**(a) It bonds are selling at par & redeemed at par**

Then coupon = Current Yield YTM

5 Years Bond

P.V. of Interest + P.V. of Principal = Market Price

YTM (8%)

Present Value of Interest (80×3.993)	= ₹ 319
Present Value of Principal ($1,000 \times 0.681$)	= ₹ 681
	= ₹ 1,000

YTM (6%)

Present Value of Interest (80×4.212)	= ₹ 337
Present Value of Principal ($1,000 \times 0.747$)	= ₹ 747
	= ₹ 1084

P.V. of Interest = ₹ 319 – ₹ 337 = ₹ 18

P.V. of Principal = ₹ 681 – 747 = ₹ 66

Market = ₹ 1,000 – 1,084 = ₹ 84

If yield decreases to 6% then price of bond will Increase by ₹ 84 due to

Change in P.V. of Interest = $\frac{₹ 18}{84} \times 100 = 21.43\%$

Change in P.V. of Principal = $\frac{₹ 66}{84} \times 100 = 78.57\%$

20 Years Bond

	P.V. of Interest	P.V. Principal	Market Price
Yield 8 %	$(80 \times 9.818) = 786$	$(1,000 \times 0.214) = 214$	1,000
Yield 6 %	$(80 \times 11.470) = 918$	$(1,000 \times 0.312) = 312$	1,230
	132	98	230

If yield decreases to 6% then bond price will increase by ₹ 230

$$\text{Due to P.V. of Interest} = \frac{132}{230} \times 100 = 57.39\%$$

$$\text{Due to P.V. of Principal} = \frac{98}{230} \times 100 = 42.61\%$$

(b) Duration in the average time taken to recollect back the investment

Years (A)	Coupon Payment (₹)	Redemption (₹)	Total (₹) (B)	PVIF (₹) (C)	(A)×(B)×(C) (₹)
1	70	-	70	0.935	65.45
2	70	-	70	0.873	122.22
3	70	-	70	0.816	171.36
4	70	-	70	0.763	213.64
5	70	-	70	0.713	249.55
6	70	1000	1070	0.666	4,275.72
				ΣABC	<u>5,097.94</u>

$$\text{Duration} = \frac{\Sigma ABC}{\text{Purchase Price}} = \frac{\text{₹ } 5,097.94}{\text{₹ } 1,000} = 5.098 \text{ Years}$$

(c) If YTM goes up to 10%, current price of the bond will decrease to

$$\text{₹ } 70 \times \text{PVIFA } (10\%, 6) + \text{₹ } 1000 \text{ PVIF } (10\%, 6)$$

$$\text{₹ } 304.85 + \text{₹ } 564.00 = \text{₹ } 868.85$$

Years (A)	Inflow (₹) (B)	PVIF (₹) (C)	(A) × (B) × (C) (₹)
1	70	0.909	65.45
2	70	0.826	115.64
3	70	0.751	157.71
4	70	0.683	191.24
5	70	0.621	217.35
6	1070	0.564	3,620.88
		ΣABC	<u>4,366.45</u>

New Duration ₹ 4,366.45 / ₹ 868.85 = 5.025 years

The duration of bond decreases, reason being the receipt of slightly higher portion of one's investment on the same intervals.

Question – 16

Mr. A is planning for making investment in bonds of one of the two companies X Ltd. and Y Ltd. The detail of these bonds is as follows:

Company	Face Value	Coupon Rate	Maturity Period
X Ltd.	₹ 10,000	6%	5 Years
Y Ltd.	₹ 10,000	4%	5 Years

The current market price of X Ltd.'s bond is ₹10,796.80 and both bonds have same Yield to Maturity (YTM). Since Mr. A considers duration of bonds as the basis of decision making, you are required to calculate the duration of each bond and you decision.

Solution:

To calculate duration of bond we need YTM, which shall be calculated as follows:

Let us try NPV of Bond @ 5%

$$\begin{aligned}
 &= \frac{600}{(1.05)^1} + \frac{600}{(1.05)^2} + \frac{600}{(1.05)^3} + \frac{600}{(1.05)^4} + \frac{10,600}{(1.05)^5} - 10,796.80 \\
 &= ₹ 571.43 + ₹ 544.22 + ₹ 518.30 + ₹ 493.62 + ₹ 8,305.38 - ₹ 10,796.80 \\
 &= - ₹ 363.85
 \end{aligned}$$

Let us now try NPV @ 4%

$$\begin{aligned}
 &= \frac{600}{(1.04)^1} + \frac{600}{(1.04)^2} + \frac{600}{(1.04)^3} + \frac{600}{(1.04)^4} + \frac{10,600}{(1.04)^5} - 10,796.80 \\
 &= ₹ 576.92 + ₹ 554.73 + ₹ 533.40 + ₹ 512.88 + ₹ 712.43 - ₹ 10,796.80 \\
 &= ₹ 93.56
 \end{aligned}$$

Let us now interpolation formula

$$= 4\% + \frac{93.56}{93.56 - (-363.85)} \times (5\% - 4\%)$$

$$= 4\% + \frac{93.56}{93.56 - (-363.85)}$$

$$= 4\% + \frac{93.56}{457.41} = 4.20\%$$

Duration of X Ltd.' s Bond

Year	Cash flows	P.V. @ 4.2%		Proportion bond value	Proportion bond value × time (Years)
1	600	0.9597	575.82	0.0533	0.0533
2	600	0.9210	552.60	0.0512	0.1024
3	600	0.8839	530.34	0.0491	0.1473
4	600	0.8483	508.98	0.0472	0.1888
5	10600	0.8141	<u>8,629.46</u>	<u>0.7992</u>	<u>3.9960</u>
			<u>10,797.20</u>	<u>1.0000</u>	<u>4.4878</u>

Duration of the Bond is 4.4878 years say 4.49 years.

Duration of Y Ltd.'s Bond

Year	Cash flows	P.V. @ 4.2%		Proportion bond value	Proportion bond value × time (Years)
1	400	0.9597	383.88	0.0387	0.0387
2	400	0.9210	368.40	0.0372	0.0744
3	400	0.8839	253.56	0.0357	0.1071
4	400	0.8483	339.32	0.0342	0.1368
5	10400	0.8141	<u>8,466.64</u>	<u>0.8542</u>	<u>4.2710</u>
			<u>9,911.80</u>	<u>1.0000</u>	<u>4.6280</u>

Duration of the Bond is 4.6280 years say 4.63 years.

Decision: Since the duration of Bond of X Ltd. is lower and also carrying higher interest rate hence it should be preferred.

Question – 17

The following data are available for a bond:

Face Value ₹ 10,000 to be redeemed at par on maturity

Coupon rate 8.5%

Years to Maturity 5 years