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Exercise : Bond Valuation & Risk Sensitivity

1. Find the amount to which the Principal **P** will grow in **n** years with an interest rate of **r** % in each of the following cases.

- (a) $P = \text{Rs.}1000$, $n = 5$ years, $r = 12\%$ simple interest
- (b) $P = \text{Rs.}1000$, $n = 5$ years, $r = 12\%$ compounded annually
- (c) $P = \text{Rs.}1000$, $n = 5$ years, $r = 12\%$ compounded semi-annually
- (d) $P = \text{Rs.}1000$, $n = 5$ years, $r = 12\%$ compounded quarterly
- (e) $P = \text{Rs.}1000$, $n = 5$ years, $r = 12\%$ compounded monthly

2. Find the present value of a Bond which has the following cash flow streams in next 5 years assuming market interest rate as 8% compounded annually.

Year	Cash Flows
1	Rs.10,000
2	Rs.40,000
3	Rs.40,000
4	Rs.40,000
5	Rs.30,000

If a lump sum amount of Rs.1,25,000 is also given at the end then what is the total present value of the Bond ?

3. Find the interest rate or rate of return or yield for a Bond in each of the following cases:
- (a) You give a loan of Rs.700/- and receive a promise to be paid Rs.749/- at the end of one year.
 - (b) You give a loan of Rs.700/- and receive a promise to be paid Rs.850/- at the end of 3 years.
 - (c) You borrow Rs.85,000/- and promise to pay back Rs.2,01,229/- at the end of 10 years.
 - (d) You borrow Rs.9,000/- and promise to make payments of Rs.2,684.80 per year for 5 years.
4. How much money must be deposited today in a Fund which pays 8% interest compounded annually in order to accumulate Rs.50,000/- in 20 years?

5. An individual borrows Rs.1,00,000/- at 8% interest rate compounded annually. Equal annual payments are to be made for 6 years. However at the time of the 4th payment, the individual elects to pay off the loan. How much should be paid?
6. What is the present worth of operating expenditures of Rs.1,00,000/- per year which are assumed to be incurred continuously throughout in 8-year period if the effective annual rate of interest is 12%?
7. Mr.Ramesh assumes that he needs Rs.20,00,000/- for his son's engineering education after 10 years. How much must be deposited at the end of each year in the Bank at 8% compound interest to meet the future educational expenses? What would be the EMI ?
8. There are 4 Bonds namely A, B, C and D, each having a face value of Rs.50,000/- at maturity. The annual coupons of these bonds for the next 5 years are given in the following table. If the prevailing interest rate is 8% compounded annually, find the present value of each of these bonds? In which Bond would you prefer to invest and why ?

Year	A	B	C	D
1	1000	3000	2000	1500
2	1500	2500	2000	2000
3	2000	2000	2000	3000
4	2500	1500	2000	2000
5	3000	1000	2000	1500

9. Find the average of the present values of the four bonds in the above example-8. If an investor is buying each of these bonds by paying this average amount, find the yield of each of the bonds. Find the yield of each of the bonds at the beginning of the 2nd year and also for the subsequent years. What is the inference drawn from the pattern of yields for each of the bonds and across all the four bonds ?
10. Verify by eliciting suitable examples the following statements of the Bond Value Theorems(BVT) :
 - a. BVT-1 : If a bond's Yield to maturity (YTM) increases, then its price decreases and conversely If a bond's YTM decreases, then its price increases.
 - b. BVT-2 : If a bond's YTM does not change over its life, then the size of its discount or premium will decrease as its life gets shorter.
 - c. BVT-3 : If a bond's YTM does not change over its life, then the size of its discount or premium will decrease at an increasing rate as its life gets shorter.
 - d. BVT-4: A decrease in a bond's yield will raise the bond's price by an amount that is greater in size than the corresponding fall in the bond's

price that would occur if there were an equal-sized increase in the bond's yield.

- e. BVT-5: The percentage change in a bond's price owing to a change in its yield will be smaller if its coupon rate is higher (not applicable to perpetuities and bonds with life less than one year)
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- 11. A bond has the following characteristics : Face value = Rs.12000, coupon rate = 9%, yield = 10% compounded annually, maturity = 5 years, Calculate its Duration as well as modified duration?
 - 12. What is the duration of a 8.75% bond with face value Rs.10000 maturing on 31/03/2018, assuming the prevailing yield to be 9% on 04/08/2014..
 - 13. Compute the duration of each of the four bonds of Example-8 and give your opinion of choosing a suitable bond among them as an investor. If an investor's portfolio of assets consists of these four bonds, what is the duration of the portfolio ?
 - 14. A bank is having following positions, Total Assets = Rs.600cr, Total Liabilities = Rs450cr, Duration of Assets = 3.25 years and duration of liabilities = 1.75 years. (a) Calculate the duration Gap in years, (b) How does duration Gap increase by increasing Duration of assets or Duration of liabilities? (c) assuming banks current interest rate as 9%, calculate change in net worth, if there is 2% increase in interest rates, and then 3 % decreases, when will be the bank in healthy position?
 - 15. A bond has following characteristics : Face value = Rs.12400, coupon rate = 10%, yield = 10% compounded annually, maturity = 5 years. If price of bond decreases by 3%, what will be the exact change in price of a bond, (b) What will be the change in value of a firm after price change.
 - 16. For the given balance sheet of a bank compute the gap, rate sensitive gap, duration of assets, duration of liabilities, duration gap, duration ratio and interest rate sensitivity in the following cases (a) 1% change in both assets and liabilities, (b) 2% change in assets and 1% change in liabilities.

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Some Useful Formulae for Present value and Duration Analysis

$PV = \frac{FV}{(1+r)^n}$	<i>Finds present value (PV) of the cash flow of future value (FV) after n years with interest rate r compounded annually. It is a Zero Coupon Bond.</i>
$PV = \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \dots + \frac{C_t + FV}{(1+r)^t}$	<i>Finds net present value (PV) of a series of cash flows (C_t) including final value (FV) after t number of time periods with fixed interest rate r compounded annually.</i>
$PV = \frac{C_1}{(1+r_1)^1} + \frac{C_2}{(1+r_2)^2} + \dots + \frac{C_t + FV}{(1+r_t)^t}$	<i>Finds net present value (PV) of a series of cash flows (C_t) in t number of time periods with variable interest rate r_t compounded annually.</i>
$D = \frac{\sum_{t=1}^N t * PV(t)}{\sum_{t=1}^N PV(t)}$	<i>Finds duration (D) of a series of cash flows, PV(t) is present value of bonds coupon at time t</i>
$MD = \frac{D}{1+r}$	<i>Finds modified duration (MD) where D is duration & r is interest rate</i>
$Price\ Change = \frac{(-D)}{(1+r)}(\Delta r)(100)$	<i>Finds change in value of price of a bond, Δr is change in interest rate</i>
$\Delta NW = \left[-D_A \frac{\Delta i}{(1+i)} TA \right] - \left[-D_L \frac{\Delta i}{(1+i)} TL \right]$	<i>Finds change in net worth (NW) of a firm, D_A is duration of assets, D_L is duration of liabilities, TA is total assets and TL is total liabilities.</i>
$Dgap = DA - \left(DL * \frac{TL}{TA} \right)$	<i>Calculates duration gap(DGap), where D_A & D_L are duration of assets & duration of liabilities respectively</i>
$DR = \frac{D_A}{D_L}$	<i>Finds duration ratio(DR), where D_A & D_L are duration of assets & duration of liabilities respectively</i>

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Some Useful Financial Functions in MS-Excel

Function	Function Syntax with arguments	Description
Duration	DURATION (settlement, maturity, coupon,yld,frequency,basis)	Returns the annual duration of a security with periodic interest payments.
FV	FV(rate,nper,pmt,pv,type)	Returns the future value of an investment
MDURATION	MDURATION (settlement, maturity, coupon,yld,frequency,basis)	Returns the McCauley modified duration for a security with an assumed par value of 100 units
PV	PV (rate, nper, pmt,fv,type)	Returns the present value of an investment.
NPV	NPV (rate, value1,value2, ...)	Returns the net present value of an investment based on a series of periodic cash flows and a discount rate
RATE	RATE (nper, pmt, pv,fv, type, guess)	Returns the interest rate per period of an annuity
YIELD	YIELD (settlement, maturity, rate, pr,redemption,frequency,basis)	Returns the yield on a security that pays periodic interest
ACCRNT	ACCRINT (issue, first_interest, settlement, rate, par, frequency, basis)	Returns the accrued interest for a security that pays periodic interest
ACCRINT	ACCRINTM (issue, Settlement, rate, par, basis)	Returns the accrued interest for a security that pays interest at maturity
EFFECT	EFFECT (nominal_rate, npery)	Returns the effective annual interest rate
FVSCCHEDULE	FVSCCHEDULE (principal, schedule)	Returns the future value of an initial principal after applying a series of compound interest rates
INTRATE	INTRATE (settlement, maturity, Investment, redemption, basis)	Returns the interest rate for a fully invested security
IRR	IRR (values, guess)	Returns the internal rate of return for a series of cash flows
PMT	PMT (rate, per, PV, fv, type)	Returns the periodic payment for an annuity

Excel Arguments Description:

1. **Settlement** is the security's settlement date. The security settlement date is the date after the issue date when the security is traded to the buyer.
2. **Maturity** is the security's maturity date. The maturity date is the date when the security expires.
3. **Coupon** is the securities annual coupon rate.
4. **Yld** is the security's annual yield.
5. **Frequency** is the number of coupon payments per year
6. **Basis** is the type of day count basis to use.
7. **rate** is the interest rate per period.
8. **Nper** is the total number of payment periods in an annuity
9. **Pmt** is the payment made each period
10. **Pv** is the present value
11. **Type** is the number 0 or 1 and indicates when payments are due.
12. **Rate** is the interest rate per period
13. **Nper** is the total number of payment periods in an annuity.
14. **Pmt** is the payment made each period and cannot change over the life of the annuity.
15. **Fv** is the future value, or a cash balance you want to attain after the last payment is made
16. **Type** is the number 0 or 1 and indicates when payments are due.
17. **Pr** is the security's price per Rs.100 face value.
18. **Redemption** is the security's redemption value per Rs.100 face value.
19. **Frequency** is the number of coupon payments per year
20. **Issue** is the security's issue date.
21. **First interest** is the security's first interest date.
22. **Nominal_rate** is the nominal interest rate.
23. **Npery** is the number of compounding periods per year.