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# **FINC 462/662 -- Fixed Income Securities**

FINC-462/662: Fixed Income Securities

## **Exercise 02**

### **Time Value of Money Concepts**

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## **Question 1**

```

• begin
•   q1_T1 = 10
•   q1_T2 = 25
•   q1_r = 0.02
•   q1_F = 1000
•   q1_c = 0.025
•   q1_cf1 = q1_c * q1_F
•   #part 1
•   q1_01 = q1_cf1/q1_r*(1-1/(1+q1_r)^q1_T1)
•   #part 2
•   q1_02 = q1_cf1/q1_r*(1-1/(1+q1_r)^q1_T2)+q1_F/(1+q1_r)^q1_T2
•   #part 3
•   q1_03 = q1_02 - q1_01
•   display("")
• end

```

Suppose Firm A issues a bond with 25 years to maturity and par value of \$1000. This bond pays no coupon interest for the first 10 years. It then pays annual coupons at an (annual) rate of 2.5% until maturity. Assume a 2.0% discount rate (annual rate that is annually compounded).

1. Calculate the value of a 10-year annuity that pays 2.5% on a \$ 1000 notional amount annually.

Hint

Value of annuity: 1000 \* 0.025

2. Calculate the value of a coupon bond which matures in 10 years and pays annual coupons at an (annual) rate of 2.5%.

Hint

Value of coupon bond: 1000 \* 0.025 \* 10 + 1000 \* 0.9057

3. Calculate the value of Firm A's bond.

Hint

The bond value is the difference between the value of coupon bond in part 2 and the annuity in part 1.

Bond value: 975.0007 \* 1000 = 975.0007

## Question 2

```

• begin
•   q2_T1 = 13
•   q2_F1 = 330
•   q2_C1 = 25.385
•   q2_T21 = 10
•   q2_T22 = 3
•   q2_T23 = 24
•   q2_F2 = 300
•   q2_C21 = 20
•   q2_C22 = 20
•   q2_C23 = 4.17
•   q2_r = 0.05
•
•   #part 1
•   q2_01 = q2_C1/q2_r * (1 - 1/(1+q2_r)^q2_T1)
•
•   #part 2
•   q2_02_01 = q2_C21/q2_r * (1 - 1/(1+q2_r)^q2_T21) #T21-year annuity
•   q2_02_02 = 1/(1+q2_r)^(q2_T21) * (q2_C23/q2_r*(1-1/(1+q2_r)^q2_T23)) #PV of T23-
year annuity starting in year T21+1, need to discount back to day using T21
•   q2_02_03 = 1/(1+q2_r)^(q2_T21) * (q2_C22/q2_r*(1-1/(1+q2_r)^q2_T22)) #PV of T22-
year annuity starting in year T21+1, need to discount back to day using T21
•   q2_02 = q2_02_01 + q2_02_02 + q2_02_03
•
•   display("")
• end

```

After graduation, you joined a large pension fund. Your new boss asks you to evaluate two investment alternatives. Assume a 5.0% discount rate (annual rate that is annually compounded). Your task is to compare the value of the two investments.

- Alternative A is a 13-year investment and it pays \$25.385 million for 13 years.
- Alternative B pays \$20 million for 10 years. Then, it pays \$24.17 million through year 13. After that, it pays \$4.17 million for the next 21 years.

1. Calculate the value of Alternative A.

Hint

Alternative A: 255.455

2. Calculate the value of Alternative B.

Hint

Alternative B: 255.455

## Question 3

---

You want to have 400,000 to purchase a house 10 years from today. Assuming you can earn 3 percent compounded annually, how much money must you invest today?

Hint

```
• Markdown.parse("""
• !!! hint
• Solution: \\$`$(roundmult(400000/(1+.03)^10,0.01))`
• """)
```

## Question 4

---

You want to have 400,000 to purchase a house 10 years from today. Assuming you can earn 3 percent compounded continuously, how much money must you invest today?

Hint

```
• Markdown.parse("""
• !!! hint
• Solution: \\$`$(roundmult(400000*exp(-0.03*10),0.01))`
• """)
```

## Question 5

---

How much would you be willing to pay for a contract that pays 2,000 per year for 25 years? Assume that the discount rate is 5 percent and annual compounding.

Hint

```
• Markdown.parse("""
• !!! hint
• Solution: \\$`$(roundmult(2000/0.05*(1 - 1/(1+0.05)^25),0.01))`
• """)
```

## Question 6

---

Solve for the price of a coupon bond with a coupon rate of 10 percent and maturity of 25 years. The

discount rate is 5% (annually compounded). Assume annual coupons and face value of 100.0

Hint

```
• Markdown.parse("""
• !!! hint
• Solution: \\$`$(roundmult(10/0.05*(1-1/(1+0.05)^25)+100/(1+0.05)^25,0.01))`
• """)
```

## Question 7

What would be the most you would be willing to pay for a share of preferred stock paying a semiannual coupon of 6.25? Assume that the discount rate is 5 percent.

Hint

```
• Markdown.parse("""
• !!! hint
• Solution: \\$`$(roundmult(6.25/(0.05/2),0.01))`
• """)
```

## Question 8

Suppose, you sold an apartment house by accepting 1,000,000 down and monthly payments of 15,000 per month for 10 years. You place the entire down payment and all payments as they are received into a money market account earning 5 percent compounded monthly. What is the amount you will have accumulated in the money market account when the mortgage is paid off?

```
• begin
• q7_1 = 1000000*(1+0.05/12)^(12*10) #Step 1: The FV of $1M invested for 10 years
• q7_2 = 15000/(0.05/12)*(1 - 1/(1+0.05/12)^(12*10)) #Step 2: You will get an annuity
  for 10 years which pays $15K per month. Compute the PV of this annuity
• q7_3 = q7_2 *(1+0.05/12)^120 #Step 3: Take the PV of the annuity computed in step 2
  and invest that as above for a period of 10 years
• q7 = q7_1 + q7_3 #Step 4: Add the amounts in Step 1 and Step 4 to arrive at the final
  answer
• display("")
• end
```

Hint

## Question 9

You plan to purchase a share of common stock in an airline. The dividends on this common stock have been growing at a 3 percent rate for the past 20 years, and you expect this to continue indefinitely. Dividends are expected to be 10 per share at the end of the year ahead, and you think 15 percent is the appropriate rate of return on this stock. How much would you be willing to pay for this stock?

Hint

```
• Markdown.parse("""
• !!! hint
• Solution: \\$`$(roundmult(10/(0.15-0.03),0.01))`
• """)
```

## Question 10

What is the present value of a stream of cash flows expected to grow at a 10 percent rate per year for 5 years and then remain constant thereafter until the final payment in 30 years. The payment at the end of the first year is 1,000 and the discount rate is 5.00 percent.

```
• begin
• #End of year 1 1000.00
• #End of year 2 1100.00
• #End of year 3 1210.00
• #End of year 4 1331.00
• #End of year 5 1464.10
• #End of year 6 1464.10
• #...
• #End of year 30 1464.10
•
• # First compute the PV of an annuity that lasts 25 years and pays $1464.10 per year
• q10_1=1464.1/0.05*(1 - 1/(1+0.05)^25)
• #This is the present value of the payments from year 6 to year 30 AT YEAR 5.
• #need to covert this to the PV at time 0 which is to simply discount this for 5 years
• q10_2=q10_1/(1+0.05)^5
• #Add to this the PV of the payment in the first 5 years
• q10 = q10_2+1000/1.05+1100/1.05^2 + 1210/1.05^3+1331/1.05^4+1464/1.05^5
• display("")
• end
```

Hint

## Question 11

What is the value of an annuity that has its first payment in 21 years from now and ends after paying for 24 years (i.e. it pays 24 times)? The annuity pays 10,000 per year and the discount rate is 5 percent.

```
• begin
• #The annuity starts 21 years from now and ends after 24 payments (i.e. it ends in year 45)
• #It lasts for 24 years, pays $10,000 per year, and the discount rate is 5%
• #The PV of this annuity at the start of year 20 is
• q11_1 = 10000/0.05*(1 - 1/(1.05)^24)
• #The PV of this annuity today is
• q11 = q11_1/1.05^21
• display("")
• end
```

Hint

## Question 12

Consider a Treasury bond selling at par (\$1000) with a coupon rate of 6% and 10 years to maturity. What is the price of this bond assuming the discount rate is 15%.

Hint

```
• Markdown.parse("""
• !!! hint
• Solution: \\$`$(roundmult((0.5*0.06*1000)/(0.5*0.15)*(1-1/(1+
• (0.5*0.15))^(2*10))+1000/(1+(0.5*0.15))^(2*10),0.01))`
• """)
```

