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CFA LEVEL I

Detailed Formula Sheet



Fixed Income

Topic 6 of 10 • Fully Explained

💡 Plain-English explanations 📊 Worked examples 🧠 Memory hooks ⚠️ Exam traps

Bond Features & Pricing

Money Market Yields

Spot, Par & Forward Rates

Full vs Flat Price

Duration Family

Convexity

Credit Risk

10,000+

Students Trained

350+

Batches Completed

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👋 **Topic 6 — Fixed Income!** The most **formula-dense** topic on the exam — but it all flows from one idea: a bond's price is the present value of its cash flows. This sheet walks from pricing → yields → the term structure → the **duration & convexity** risk measures → credit. Each card has the formula, a plain-English meaning, a worked example, and **memory hooks**. 📌

💡 **In Plain English** 📊 **Worked Example** 🧠 **Memory Hook** ⚠️ **Watch Out** 📌 **Key Fact**

1 📊 Bond Features & Pricing

📊 Pricing a Bond (PV of cash flows)

$$PV = \frac{PMT}{(1+r)^1} + \frac{PMT}{(1+r)^2} + \dots + \frac{PMT + FV}{(1+r)^N}$$

💡 In Plain English

A bond is worth the present value of every coupon (PMT) plus the face value (FV) returned at maturity, all discounted at the market yield r . Higher yield → lower price (they move **inversely**).

📊 Worked Example

3-yr, 5% annual coupon, par \$1,000, YTM 6%:

$PV = 50/1.06 + 50/1.06^2 + 1,050/1.06^3 = \text{\$973.27}$.

📌 Premium / Par / Discount

Coupon > YTM → **premium** (price > par); Coupon = YTM → **par**; Coupon < YTM → **discount** (price < par). Current yield = annual coupon ÷ price.

2 📈 Money Market Yields

🏦 Discount Rate vs Add-On Rate

$$\text{Discount basis: } PV = FV \times \left(1 - \frac{\text{Days}}{\text{Year}} \times DR\right)$$

$$\text{Add-on basis: } PV = \frac{FV}{1 + (\text{Days}/\text{Year}) \times AOR} \quad | \quad AOR = \frac{\text{Year}}{\text{Days}} \times \frac{FV - PV}{PV}$$

💡 In Plain English

Money-market yields are **annualized but not compounded** (simple interest). **Discount-rate** instruments (T-bills, commercial paper) quote interest *inside* the face value; **add-on** instruments (CDs, repos) add interest to the price.

⚠️ Watch Out

The discount rate divides by **FV** (not PV), so it **understates** the true return. Always convert before comparing!


Bond Equivalent Yield (the great equalizer)

BEY = the add-on rate (AOR) computed on a **365-day** year

In Plain English

To compare money-market instruments fairly, restate each as a **bond equivalent yield**: find the price, then compute the add-on rate using 365 days. Now they're all on the same footing.

Worked Example

91-day T-bill, DR 3.45%, 360-day year: $PV = 100 \times (1 - (91/360)(0.0345)) = 99.128$.

BEY = $(365/91) \times (100 - 99.128)/99.128 = \approx 3.53\%$.

3 Spot, Par & Forward Rates

The Three Curves

Spot = zero-coupon rates today • Par = coupon that prices a bond at par • Forward = a future-period rate

$$\text{Price with spot rates: } PV = \frac{PMT}{(1+z_1)^1} + \dots + \frac{PMT + FV}{(1+z_N)^N}$$

In Plain English

Spot rates are today's rates for a single future payment (zero-coupon). The no-arbitrage price discounts each cash flow at *its own* spot rate, not one single YTM.


Forward Rates from Spot Rates

$$(1 + z_B)^B = (1 + z_A)^A \times (1 + f_{A,B-A})^{(B-A)}$$

In Plain English

A forward rate is the rate, agreed today, for a loan that **starts in the future**. It's locked in by the no-arbitrage rule: investing long must equal investing short then rolling at the forward rate.

Worked Example

1-yr spot $z_1 = 4\%$, 2-yr spot $z_2 = 5\%$: $(1.05)^2 = (1.04)(1 + f) \rightarrow f = 1.1025/1.04 - 1 = 6.01\%$ (the 1-yr rate, 1 yr forward).

Memory Hook

"When the spot curve slopes up, forward rates sit above spot rates." Forwards lead the curve. 📈

4
Full Price, Flat Price & Accrued Interest

Clean vs Dirty Price

$$\text{Accrued Interest (AI)} = \frac{t}{T} \times \text{PMT}$$

$$\text{Full (dirty) price} = \text{Flat (clean) price} + \text{Accrued Interest}$$

In Plain English

Between coupon dates, the buyer owes the seller the interest earned so far (AI), where t = days since last coupon and T = days in the period. The **full price** is what you actually pay; the **flat price** is what's quoted.

Worked Example

Semiannual coupon \$30, 60 of 180 days elapsed: $\text{AI} = (60/180) \times 30 = \10 .

Flat price \$980 → full price = $980 + 10 = \$990$.

Key Fact

Duration and convexity measure the sensitivity of the **full (dirty) price** — not the flat price — to yield changes.

5
The Duration Family

Macaulay → Modified → Money → PVBP

$$\text{ModDur} = \frac{\text{MacDur}}{1 + r} \quad | \quad \% \Delta \text{PV}^{\text{Full}} \approx -\text{AnnModDur} \times \Delta \text{Yield}$$

$$\text{MoneyDur} = \text{AnnModDur} \times \text{Full Price} \quad | \quad \text{PVBP} = \frac{\text{PV}_- - \text{PV}_+}{2} \quad (\text{per 1 bp})$$

In Plain English

Macaulay = weighted-average time to get your cash flows. **Modified** = the % price change per 1% yield move. **Money** duration = the change in actual currency. **PVBP** = the price change for a single basis point.

Worked Example

MacDur 4.0, YTM 5% → $\text{ModDur} = 4.0/1.05 = 3.81$. A +100 bp yield rise → price ≈ **-3.81%**.

Special Cases

Zero-coupon: **MacDur = maturity**. Perpetuity: $\text{MacDur} = (1 + r)/r$. Longer maturity, lower coupon, lower yield → **higher** duration.



Approximate & Effective Duration

$$\text{Approx ModDur} = \frac{PV_- - PV_+}{2 \times \Delta \text{Yield} \times PV_0} \quad | \quad \text{Eff Dur} = \frac{PV_- - PV_+}{2 \times \Delta \text{Curve} \times PV_0}$$

In Plain English

Re-price the bond up and down and measure the slope. **Approximate modified** shifts the bond's *own* yield; **effective duration** shifts the whole **benchmark curve** — the right tool for bonds with **embedded options** (callable/puttable).

Worked Example

PV_0 100, ΔYield 25 bp, PV_+ 98.75, PV_- 101.28:

Approx ModDur = $(101.28 - 98.75) / (2 \times 0.0025 \times 100) = 5.06$.

Watch Out

For bonds with embedded options, use **effective duration** — cash flows aren't fixed, so yield duration doesn't apply.

6

Convexity & Price-Change Estimation



The Convexity Adjustment

$$\text{Approx Convexity} = \frac{PV_+ + PV_- - 2PV_0}{(\Delta \text{Yield})^2 \times PV_0}$$

$$\% \Delta PV^{\text{Full}} \approx (-\text{AnnModDur} \times \Delta \text{Yield}) + (\frac{1}{2} \times \text{Convexity} \times \Delta \text{Yield}^2)$$

In Plain English

The price–yield line is **curved**, not straight, so duration alone overstates the price drop and understates the rise. Convexity is the **correction term** — it's always positive for option-free bonds, helping the holder either way.

Worked Example

Using PV_0 100, PV_+ 98.75, PV_- 101.28: Convexity = $(98.75 + 101.28 - 200) / (0.0025^2 \times 100) = 48$.

For +100 bp: $\% \Delta PV \approx (-5.06 \times 0.01) + (\frac{1}{2} \times 48 \times 0.01^2) = -5.06\% + 0.24\% = -4.82\%$.

Memory Hook

"Convexity is the investor's friend." It cushions losses when yields rise and boosts gains when yields fall.

7 Credit Risk

Expected Loss & Its Components

$$\text{Expected Loss} = \text{Probability of Default (POD)} \times \text{Loss Given Default (LGD)}$$

$$\text{LGD} = \text{Exposure} \times (1 - \text{Recovery Rate})$$

In Plain English

Credit risk = the chance the issuer doesn't pay. **POD** = how likely a default is; **LGD** = how much you actually lose if it happens (after recovering some cents on the dollar). Multiply them for the **expected loss**.

Worked Example

Exposure \$1,000, recovery 40% → $\text{LGD} = 1,000 \times 0.60 = \600 . POD 2% → Expected loss = $0.02 \times 600 = \$12$.

Credit Spreads & the Yield

$$\text{Yield on a risky bond} = \text{Benchmark (risk-free) yield} + \text{Credit Spread}$$

In Plain English

Investors demand extra yield (a **spread**) to bear credit risk. When the economy weakens or an issuer is downgraded, spreads **widen** → bond prices **fall**. The spread is the market's price tag on default risk.

Key Fact

Investment grade = Baa3/BBB- and above; below that is **high yield ("junk")**. Credit analysis weighs the "4 Cs": Capacity, Collateral, Covenants, and Character.