PRACTICE PROBLEMS

The following information relates to Questions 1–8

Serena Soto is a risk management specialist with Liability Protection Advisors. Trey Hudgens, CFO of Kiest Manufacturing, enlists Soto's help with three projects. The first project is to defease some of Kiest's existing fixed-rate bonds that are maturing in each of the next three years. The bonds have no call or put provisions and pay interest annually. Exhibit 1 presents the payment schedule for the bonds.

Exhibit 1 Kiest Manufacturing Bond Payment Schedule As of 1 October 2017

Maturity Date	Payment Amount
1 October 2018	$9,572,000
1 October 2019	$8,392,000
1 October 2020	$8,200,000

The second project for Soto is to help Hudgens immunize a $20 million portfolio of liabilities. The liabilities range from 3.00 years to 8.50 years with a Macaulay duration of 5.34 years, cash flow yield of 3.25%, portfolio convexity of 33.05, and basis point value (BPV) of $10,505. Soto suggested employing a duration-matching strategy using one of the three AAA rated bond portfolios presented in Exhibit 2.

Exhibit 2 Possible AAA Rated Duration-Matching Portfolios

	Portfolio A	Portfolio B	Portfolio C
Bonds (term, coupon)	4.5 years, 2.63% 7.0 years, 3.50%	3.0 years, 2.00% 6.0 years, 3.25% 8.5 years, 3.88%	1.5 years, 1.25% 11.5 years, 4.38%
Macaulay duration	5.35	5.34	5.36
Cash flow yield	3.16%	3.33%	3.88%
Convexity	31.98	34.51	50.21
BPV	$10,524	$10,506	$10,516

Soto explains to Hudgens that the underlying duration-matching strategy is based on the following three assumptions.

1 Yield curve shifts in the future will be parallel.

2 Bond types and quality will closely match those of the liabilities.

3 The portfolio will be rebalanced by buying or selling bonds rather than using derivatives.

The third project for Soto is to make a significant direct investment in broadly diversified global bonds for Kiest's pension plan. Kiest has a young workforce, and thus, the plan has a long-term investment horizon. Hudgens needs Soto's help to select a benchmark index that is appropriate for Kiest's young workforce and avoids the "bums" problem. Soto discusses three benchmark candidates, presented in Exhibit 3.

Exhibit 3 Global Bond Index Benchmark Candidates

Index Name	Effective Duration	Index Characteristics
Global Aggregate	7.73	Market cap weighted; Treasuries, corporates, agency, securitized debt
Global Aggregate GDP Weighted	7.71	Same as Global Aggregate, except GDP weighted
Global High Yield	4.18	GDP weighted; sovereign, agency, corporate debt

With the benchmark selected, Hudgens provides guidelines to Soto directing her to (1) use the most cost-effective method to track the benchmark and (2) provide low tracking error.

After providing Hudgens with advice on direct investment, Soto offered him additional information on alternative indirect investment strategies using (1) bond mutual funds, (2) exchange-traded funds (ETFs), and (3) total return swaps. Hudgens expresses interest in using bond mutual funds rather than the other strategies for the following reasons.

Reason 1 Total return swaps have much higher transaction costs and initial cash outlay than bond mutual funds.

Reason 2 Unlike bond mutual funds, bond ETFs can trade at discounts to their underlying indexes, and those discounts can persist.

Reason 3 Bond mutual funds can be traded throughout the day at the net asset value of the underlying bonds.

1 Based on Exhibit 1, Kiest's liabilities would be classified as:

A Type I.

B Type II.

C Type III.

2 Based on Exhibit 2, the portfolio with the greatest structural risk is:

A Portfolio A.

B Portfolio B.

C Portfolio C.

3 Which portfolio in Exhibit 2 fails to meet the requirements to achieve immunization for multiple liabilities?

A Portfolio A

B Portfolio B

C Portfolio C

4 Based on Exhibit 2, relative to Portfolio C, Portfolio B:

A has higher cash flow reinvestment risk.

B is a more desirable portfolio for liquidity management.

C provides less protection from yield curve shifts and twists.

5 Soto's three assumptions regarding the duration-matching strategy indicate the presence of:

A model risk.

B spread risk.

C counterparty credit risk.

6 The global bond benchmark in Exhibit 3 that is *most* appropriate for Kiest to use is the:

A Global Aggregate Index.

B Global High Yield Index.

C Global Aggregate GDP Weighted Index.

7 To meet both of Hudgens's guidelines for the pension's bond fund investment, Soto should recommend:

A pure indexing.

B enhanced indexing.

C active management.

8 Which of Hudgens's reasons for choosing bond mutual funds as an investment vehicle is correct?

A Reason 1

B Reason 2

C Reason 3

The following information relates to questions 9–17

SD&R Capital (SD&R), a global asset management company, specializes in fixed-income investments. Molly Compton, chief investment officer, is meeting with a prospective client, Leah Mowery of DePuy Financial Company (DFC).

Mowery informs Compton that DFC's previous fixed income manager focused on the interest rate sensitivities of assets and liabilities when making asset allocation decisions. Compton explains that, in contrast, SD&R's investment process first analyzes the size and timing of client liabilities, then builds an asset portfolio based on the interest rate sensitivity of those liabilities.

Compton notes that SD&R generally uses actively managed portfolios designed to earn a return in excess of the benchmark portfolio. For clients interested in passive exposure to fixed-income instruments, SD&R offers two additional approaches.

Approach 1	Seeks to fully replicate the Bloomberg Barclays US Aggregate Bond Index.
Approach 2	Follows an enhanced indexing process for a subset of the bonds included in the Bloomberg Barclays US Aggregate Bond Index. Approach 2 may also be customized to reflect client preferences.

To illustrate SD&R's immunization approach for controlling portfolio interest rate risk, Compton discusses a hypothetical portfolio composed of two non-callable, investment-grade bonds. The portfolio has a weighted average yield-to-maturity of 9.55%, a weighted average coupon rate of 10.25%, and a cash flow yield of 9.85%.

Mowery informs Compton that DFC has a single $500 million liability due in nine years, and she wants SD&R to construct a bond portfolio that earns a rate of return sufficient to pay off the obligation. Mowery expresses concern about the risks associated with an immunization strategy for this obligation. In response, Compton makes the following statements about liability-driven investing:

Statement 1 Although the amount and date of SD&R's liability is known with certainty, measurement errors associated with key parameters relative to interest rate changes may adversely affect the bond portfolios.

Statement 2 A cash flow matching strategy will mitigate the risk from non-parallel shifts in the yield curve.

Compton provides the four US dollar–denominated bond portfolios in Exhibit 1 for consideration. Compton explains that the portfolios consist of non-callable, investment-grade corporate and government bonds of various maturities because zero-coupon bonds are unavailable.

Exhibit 1 Proposed Bond Portfolios to Immunize SD&R Single Liability

	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4
Cash flow yield	7.48%	7.50%	7.53%	7.51%
Average time to maturity	11.2 years	9.8 years	9.0 years	10.1 years
Macaulay duration	9.8	8.9	8.0	9.1
Market value weighted duration	9.1	8.5	7.8	8.6
Convexity	154.11	131.75	130.00	109.32

The discussion turns to benchmark selection. DFC's previous fixed-income manager used a custom benchmark with the following characteristics:

Characteristic 1 The benchmark portfolio invests only in investment-grade bonds of US corporations with a minimum issuance size of $250 million.

Characteristic 2 Valuation occurs on a weekly basis, because many of the bonds in the index are valued weekly.

Characteristic 3 Historical prices and portfolio turnover are available for review.

Compton explains that, in order to evaluate the asset allocation process, fixed-income portfolios should have an appropriate benchmark. Mowery asks for benchmark advice regarding DFC's portfolio of short-term and intermediate-term bonds, all denominated in US dollars. Compton presents three possible benchmarks in Exhibit 2.

Exhibit 2 Proposed Benchmark Portfolios

Benchmark	Index	Composition	Duration
1	Bloomberg Barclays US Bond Index	80% US government bonds 20% US corporate bonds	8.7
2 Index Blend	50% Bloomberg Barclays US Corporate Bond Index 50% Bloomberg Barclays Short-Term Treasury Index	100% US corporate bonds 100% short-term US government debt	7.5 0.5
3	Bloomberg Barclays Global Aggregate Bond Index	60% EUR-denominated corporate bonds 40% US-denominated corporate debt	12.3

9 The investment process followed by DFC's previous fixed-income manager is *best* described as:

A asset-driven liabilities.

B liability-driven investing.

C asset–liability management.

10 Relative to Approach 2 of gaining passive exposure, an advantage of Approach 1 is that it:

A reduces the need for frequent rebalancing.

B limits the need to purchase bonds that are thinly traded.

C provides a higher degree of portfolio risk diversification.

11 Relative to Approach 1 of gaining passive exposure, an advantage of Approach 2 is that it:

A minimizes tracking error.

B requires less risk analysis.

C is more appropriate for socially responsible investors.

12 The two-bond hypothetical portfolio's immunization goal is to lock in a rate of return equal to:

A 9.55%.

B 9.85%.

C 10.25%.

13 Which of Compton's statements about liability-driven investing is (are) correct?

A Statement 1 only.

B Statement 2 only.

C Both Statement 1 and Statement 2.

14 Based on Exhibit 1, which of the portfolios will *best* immunize SD&R's single liability?

A Portfolio 1

B Portfolio 2

C Portfolio 3

15 Which of the portfolios in Exhibit 1 *best* minimizes the structural risk to a single-liability immunization strategy?

A Portfolio 1

B Portfolio 3

C Portfolio 4

16 Which of the custom benchmark's characteristics violates the requirements for an appropriate benchmark portfolio?

A Characteristic 1

B Characteristic 2

C Characteristic 3

17 Based on DFC's bond holdings and Exhibit 2, Compton should recommend:

A Benchmark 1.

B Benchmark 2.

C Benchmark 3.

The following information relates to questions 18–23

Doug Kepler, the newly hired chief financial officer for the City of Radford, asks the deputy financial manager, Hui Ng, to prepare an analysis of the current investment portfolio and the city's current and future obligations. The city has multiple liabilities of different amounts and maturities relating to the pension fund, infrastructure repairs, and various other obligations.

Ng observes that the current fixed-income portfolio is structured to match the duration of each liability. Previously, this structure caused the city to access a line of credit for temporary mismatches resulting from changes in the term structure of interest rates.

Kepler asks Ng for different strategies to manage the interest rate risk of the city's fixed-income investment portfolio against one-time shifts in the yield curve. Ng considers two different strategies:

Strategy 1: Immunization of the single liabilities using zero-coupon bonds held to maturity.

Strategy 2: Immunization of the single liabilities using coupon-bearing bonds while continuously matching duration.

The city also manages a separate, smaller bond portfolio for the Radford School District. During the next five years, the school district has obligations for school expansions and renovations. The funds needed for those obligations are invested in the Bloomberg Barclays US Aggregate Index. Kepler asks Ng which portfolio management strategy would be most efficient in mimicking this index.

A Radford School Board member has stated that she prefers a bond portfolio structure that provides diversification over time, as well as liquidity. In addressing the board member's inquiry, Ng examines a bullet portfolio, a barbell portfolio, and a laddered portfolio.

18 A disadvantage of Strategy 1 is that:

A price risk still exists.

B interest rate volatility introduces risk to effective matching.

C there may not be enough bonds available to match all liabilities.

19 Which duration measure should be matched when implementing Strategy 2?

A Key rate

B Modified

C Macaulay

20 An upward shift in the yield curve on Strategy 2 will *most likely* result in the:

A price effect cancelling the coupon reinvestment effect.

B price effect being greater than the coupon reinvestment effect.

C coupon reinvestment effect being greater than the price effect.

21 The effects of a non-parallel shift in the yield curve on Strategy 2 can be reduced by:

A minimizing the convexity of the bond portfolio.

B maximizing the cash flow yield of the bond portfolio.

C minimizing the difference between liability duration and bond-portfolio duration.

22 Ng's response to Kepler's question about the most efficient portfolio management strategy should be:

A full replication.

B active management.

C an enhanced indexing strategy.

23 Which portfolio structure should Ng recommend that would satisfy the school board member's preference?

A Bullet portfolio

B Barbell portfolio

C Laddered portfolio

SOLUTIONS

1 A is correct. Type I liabilities have cash outlays with known amounts and timing. The dates and amounts of Kiest's liabilities are known; therefore, they would be classified as Type I liabilities.

2 C is correct. Structural risk arises from the design of the duration-matching portfolio. It is reduced by minimizing the dispersion of the bond positions, going from a barbell structure to more of a bullet portfolio that concentrates the component bonds' durations around the investment horizon. With bond maturities of 1.5 and 11.5 years, Portfolio C has a definite barbell structure compared with those of Portfolios A and B, and it is thus subject to a greater degree of risk from yield curve twists and non-parallel shifts. In addition, Portfolio C has the highest level of convexity, which increases a portfolio's structural risk.

3 A is correct. The two requirements to achieve immunization for multiple liabilities are for the money duration (or BPV) of the asset and liability to match and for the asset convexity to exceed the convexity of the liability. Although all three portfolios have similar BPVs, Portfolio A is the only portfolio to have a lower convexity than that of the liability portfolio (31.98, versus 33.05 for the $20 million liability portfolio), and thus, it fails to meet one of the two requirements needed for immunization.

4 B is correct. Portfolio B is a laddered portfolio with maturities spread more or less evenly over the yield curve. A desirable aspect of a laddered portfolio is liquidity management. Because there is always a bond close to redemption, the soon-to-mature bond can provide emergency liquidity needs. Barbell portfolios, such as Portfolio C, have maturities only at the short-term and long-term ends and thus are much less desirable for liquidity management.

5 A is correct. Soto believes that any shift in the yield curve will be parallel. Model risk arises whenever assumptions are made about future events and approximations are used to measure key parameters. The risk is that those assumptions turn out to be wrong and the approximations are inaccurate. A non-parallel yield curve shift could occur, resulting in a mismatch of the duration of the immunizing portfolio versus the liability.

6 C is correct. Kiest has a young workforce and thus a long-term investment horizon. The Global Aggregate and Global Aggregate GDP Weighted Indexes have the highest durations (7.73 and 7.71, respectively) and would be appropriate for this group. Hudgens also wants to avoid the "bums" problem, however, which arises as a result of a market-cap-weighted portfolio increasing the weight of a particular issuer or sector that has increasing borrowings. The Global Aggregate Index is a market-cap-weighted index. As a result, the Global Aggregate GDP Weighted Index is the most appropriate selection for Kiest.

7 B is correct. Low tracking error requires an indexing approach. A pure indexing approach for a broadly diversified bond index would be extremely costly because it requires purchasing all the constituent securities in the index. A more efficient and cost-effective way to track the index is an enhanced indexing strategy, whereby Soto would purchase fewer securities than the index but would match primary risk factors reflected in the index. Closely matching these risk factors could provide low tracking error.

8 B is correct. Although a significant spread between the market price of the underlying fixed-income securities portfolio and an ETF's NAV should drive an authorized participant to engage in arbitrage, many fixed-income securities

are either thinly traded or not traded at all. This situation might allow such a divergence to persist to a much greater degree for a bond ETF than might be the case in the equity market.

9 C is correct. Asset–liability management strategies consider both assets and liabilities in the portfolio decision-making process. Mowery notes that DFC's previous fixed-income manager attempted to control for interest rate risk by focusing on both the asset and the liability side of the company's balance sheet. The previous manager thus followed an asset–liability management strategy.

10 C is correct. Approach 1 is a full replication approach, whereas Approach 2 follows an enhanced indexing strategy. Both full replication and enhanced indexing can be used to establish a passive exposure to the bond market. Under full replication, the manager buys or sells bonds when there are changes to the index. The larger number of index constituents associated with full replication provides a higher degree of risk diversification compared with an enhanced indexing strategy.

11 C is correct. Enhanced indexing is especially useful for investors who consider environmental, social or other factors when selecting a fixed-income portfolio. Environmental, social, and corporate governance (ESG) investing, also called socially responsible investing, refers to the explicit inclusion or exclusion of some sectors, which is more appropriate for an enhanced index strategy relative to a full index replication strategy. In particular, Approach 2 may be customized to reflect client preferences.

12 B is correct. Immunization is the process of structuring and managing a fixed-income portfolio to minimize the variance in the realized rate of return and to lock in the cash flow yield (internal rate of return) on the portfolio, which in this case is 9.85%.

13 C is correct. Compton is correct that measurement error can arise even in immunization strategies for Type 1 cash flows, which have set amounts and set dates. Also, a parallel shift in yield curves is a sufficient but not a necessary condition to achieve the desired outcome. Non-parallel shifts as well as twists in the yield curve can change the cash flow yield on the immunizing portfolio; however, minimizing the dispersion of cash flows in the asset portfolio mitigates this risk. As a result, both statements are correct.

14 B is correct. In the case of a single liability, immunization is achieved by matching the bond portfolio's Macaulay duration with the horizon date. DFC has a single liability of $500 million due in nine years. Portfolio 2 has a Macaulay duration of 8.9, which is closer to 9 than that of either Portfolio 1 or 3. Therefore, Portfolio 2 will best immunize the portfolio against the liability.

15 C is correct. Structural risk to immunization arises from twists and non-parallel shifts in the yield curve. Structural risk is reduced by minimizing the dispersion of cash flows in the portfolio, which can be accomplished by minimizing the convexity for a given cash flow duration level. Because Portfolio 4 has the lowest convexity compared with the other two portfolios and also has a Macaulay duration close to the liability maturity of nine years, it minimizes structural risk.

16 B is correct. The use of an index as a widely accepted benchmark requires clear, transparent rules for security inclusion and weighting, investability, daily valuation, availability of past returns, and turnover. Because the custom benchmark is valued weekly rather than daily, this characteristic would be inconsistent with an appropriate benchmark.

17 B is correct. DFC has two types of assets, short term and intermediate term. For the short-term assets, a benchmark with a short duration is appropriate. For the intermediate-term assets, a benchmark with a longer duration is appropriate. In this situation, DFC may wish to combine several well-defined sub-benchmark categories into an overall blended benchmark (Benchmark 2). The Bloomberg Barclays Short-Term Treasury Index is an appropriate benchmark for the short-term assets, and SD&R uses a 50% weight for this component. The longer-duration Bloomberg Barclays US Corporate Bond Index is an appropriate benchmark for the intermediate-term assets, and SD&R uses a 50% weight for this component. As a result, Compton should recommend proposed Benchmark 2.

18 C is correct. It may be impossible to acquire zero-coupon bonds to precisely match liabilities because the city's liabilities have varying maturities and amounts. In many financial markets, zero-coupon bonds are unavailable.

19 C is correct. An investor having an investment horizon equal to the bond's Macaulay duration is effectively protected, or immunized, from the first change in interest rates, because price and coupon reinvestment effects offset for either higher or lower rates.

20 A is correct. An upward shift in the yield curve reduces the bond's value but increases the reinvestment rate, with these two effects offsetting one another. The price effect and the coupon reinvestment effect cancel each other in the case of an upward shift in the yield curve for an immunized liability.

21 A is correct. Minimizing the convexity of the bond portfolio minimizes the dispersion of the bond portfolio. A non-parallel shift in the yield curve may result in changes in the bond portfolio's cash flow yield. In summary, the characteristics of a bond portfolio structured to immunize a single liability are that it (1) has an initial market value that equals or exceeds the present value of the liability, (2) has a portfolio Macaulay duration that matches the liability's due date, and (3) minimizes the portfolio convexity statistic.

22 C is correct. Under an enhanced indexing strategy, the index is replicated with fewer than the full set of index constituents but still matches the original index's primary risk factors. This strategy replicates the index performance under different market scenarios more efficiently than the full replication of a pure indexing approach.

23 C is correct. The laddered approach provides both diversification over time and liquidity. Diversification over time offers the investor a balanced position between two sources of interest rate risk: cash flow reinvestment and market price volatility. In practice, perhaps the most desirable aspect of a laddered portfolio is liquidity management, because as time passes, the portfolio will always contain a bond close to maturity.