SOCIETY OF ACTUARIES
Quantitative Finance and Investment Core

Exam QFICORE

AFTERNOON SESSION

Date: Wednesday, November 2, 2016
Time: 1:30 p.m. – 3:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 5 questions numbered 11 through 15 for a total of 40 points. The points for each question are indicated at the beginning of the question.

2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.

3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.

2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.

3. The answer should be confined to the question as set.

4. When you are asked to calculate, show all your work including any applicable formulas. When you are asked to recommend, provide proper justification supporting your recommendation.

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate morning or afternoon session for Exam QFICORE.

6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.

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Exam QFICORE-Front Cover

****BEGINNING OF EXAMINATION****
Afternoon Session
Beginning with Question 11

11. (*9 points*) You are given the following information on ABC Life Insurance:

	Market Value ($Millions)	Book Value ($Millions)	Effective Duration
Asset	510	500	8.5
Insurance Liability*	495	390	12
Other Liability	50	50	0.08
Surplus	-35	60	
Required Capital	n/a	4	

*Market Value of Liability is calculated using Treasury Rates+50 bps spread

Expected Insurance Net Liability Cash Flow over the next 8 years ($Millions)

	2017	2018	2019	2020	2021	2022	2023	2024
Premium	25	24	24	23	22	21	20	18
Benefit	12	13	14	14	15	16	17	17
Net	13	11	10	9	7	5	3	1

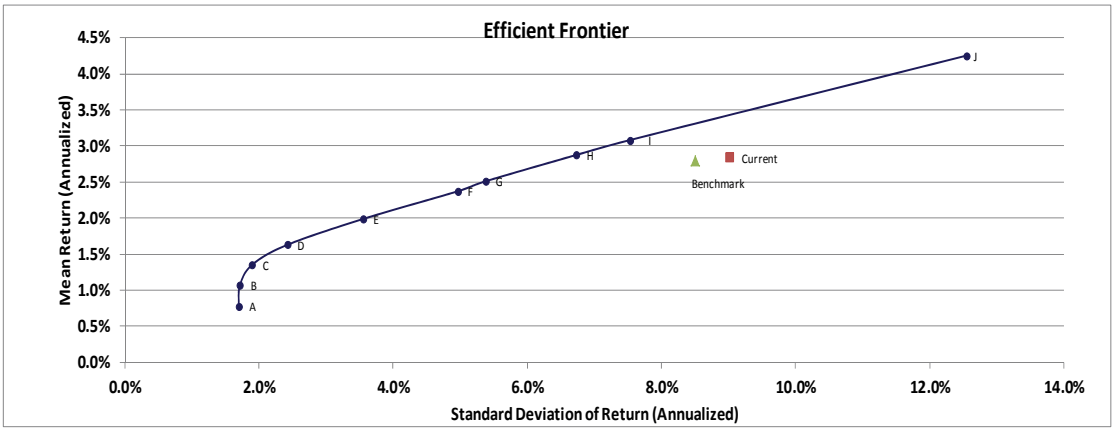
You are to use your knowledge in risk management and asset allocation to set a long-term strategic asset allocation target for the company. The investment committee wants to maintain or to improve ABC's market value surplus position in long term.

(a) (*1.5 points*) Assess whether ABC Insurance has a high ability to take risk or low ability to take risk. Justify your answer.

11. Continued

Investment Department has created an efficient frontier model with robust bond sub-calibration. This model is able to distinguish bonds with different ratings and also able to split bond maturities to a degree that it is much more refined than the other models in the market.

Following is the output from the efficient frontier model:



	Current	Bench Mark	A	B	C	D	E	F	G	H	I	J
Risk	9.02%	8.50%	1.70%	1.72%	1.90%	2.42%	3.55%	4.96%	5.38%	6.73%	7.53%	12.54%
Reward	2.84%	2.79%	0.78%	1.07%	1.35%	1.63%	1.99%	2.37%	2.51%	2.88%	3.08%	4.25%
Fixed Income Duration	8.5	8.3	1.9	1.8	1.8	1.8	2.7	3.6	3.9	4.8	5.3	10.8
Cash and short term	-	-	25%	25%	25%	25%	25%	15%	13%	5%	0%	-
Govt 1 to 3	6%	10%	66%	21%	5%	-	-	-	-	-	-	-
Govt 3 to 7	10%	6%	-	-	-	-	-	0%	-	-	-	-
Govt 7 to 10	2%	2%	-	-	-	-	-	-	-	-	-	-
Govt 10 to 20	1%	1%	-	-	-	-	-	-	-	-	-	10%
Govt 20 plus	12%	12%	-	-	-	-	-	-	-	-	-	6%
Corp A 1 to 3	15%	21%	8%	49%	35%	20%	12%	16%	5%	-	-	-
Corp A 3 to 7	21%	15%	-	-	-	-	-	0%	-	-	-	-
Corp A 7 to 10	10%	10%	-	-	-	-	-	0%	-	-	-	-
Corp A 10 to 20	2%	2%	-	-	-	1%	10%	16%	18%	23%	27%	52%
Corp A 20 plus	16%	16%	-	-	-	-	-	-	-	0%	-	-
Corp BBB 1 to 3	-	-	-	4%	25%	25%	25%	16%	25%	22%	17%	-
Corp BBB 3 to 7	-	-	-	-	-	-	-	0%	-	-	-	-
Corp BBB 7 to 10	-	-	-	-	-	-	-	-	-	-	-	-
Corp BBB 10 to 20	-	-	-	-	-	-	-	0%	-	-	-	-
Corp BBB 20 plus	-	-	-	-	-	-	-	0%	-	-	-	-
MBS 5 to 10	5%	5%	-	-	5%	11%	8%	15%	17%	25%	30%	14%
ABS 3 to 5	-	-	-	-	5%	15%	15%	15%	15%	15%	15%	-
Large Cap Equity	-	-	0%	0%	1%	3%	4%	7%	7%	10%	11%	18%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

(b) (*1.5 points*)

(i) List four types of risks the benchmark portfolio faces.

(ii) Compare the benchmark portfolio with Efficient Portfolio H regarding the risks described in part (b)(i).

Question 11 is continued on next page.

11. Continued

ABC has the minimum return objective of 2.5% and high degree of numerical risk aversion R_A equal to 7.

(c) (*3 points*)

(i) Determine the most appropriate allocation on the efficient frontier for ABC.

(ii) Describe how you can achieve a portfolio with better return to risk trade-off than the solution in part (c)(i) by utilizing the capital allocation line.

(iii) Explain why your portfolio in part (c)(ii) might not be feasible to implement.

A member of the investment committee questions whether an allocation to agency Mortgage Backed Securities (MBS) is appropriate.

(d) (*1 point*)

(i) List the advantages of investing in agency MBS.

(ii) Identify challenges encountered modeling MBS.

A member of the investment committee asks about the model used by the Investment Department.

(e) (*1 point*) Identify the efficient frontier model used by the Investment Department and assess the appropriateness of the investment portfolios determined above with respect to characteristics of ABC's liabilities.

(f) (*1 point*) Recommend alternative approaches that may be more appropriate for determining ABC's long-term allocation. Justify your answer.

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12. (*11 points*) One year ago LMN Life Insurance Company issued a 5-year Guaranteed Investment Contract (GIC) that pays a fixed lump-sum in 5 years from the issue date. The company used net proceeds of $400,000 from the sale of the GIC to purchase the following three assets for supporting eventual payout of the GIC.

Security	Market Value	Effective Duration
Liability	**400,000**	**4.8**
TB-1	150,000	7.4
TB-2	100,000	2.4
TB-3	150,000	3.8

Now one year later 4-year spot rate is 3% annual effective and the portfolio values have changed.

Security	Market Value	Effective Duration
Liability	380,000	?
TB-1	140,000	6.40
TB-2	105,000	1.40
TB-3	135,000	2.60

You consider taking one of the following three alternative actions to bring current duration of the portfolio back to the target:

1. Rebalancing the securities in the current portfolio;
2. Using interest rate futures contracts;
3. Using fixed income Exchange Traded Funds (ETF).

(a) (*1 point*) Describe the limitations of using single period immunization technique in asset/liability matching (ALM) application to rebalance duration of the portfolio.

(b) (*2 points*) Determine the new positions in securities TB-1 and TB-3, if action 1 were taken and the security TB-2 were sold entirely.

(c) (*1.5 points*) Assess advantages and disadvantages of using futures contracts rather than actual securities repositions to adjust duration of a portfolio.

12. Continued

You are given the following information about the futures contracts:

Conversion factor of the cheapest-to-deliver (CTD) security: 1.2

Duration of the CTD security: 7.5

Price of the CTD security: 92

(d) (*2 points*) Determine the number of futures contracts you would short or long, if action 2 were taken.

(e) (*1 point*) Describe sources of liquidity for fixed income ETFs.

Fixed income ETF premium/discount, which is the difference between the price and net asset value (NAV) can be expressed as a function of:

- Creation cost
- Flow factor; and
- Execution risk adjustment

(f) (*1 point*) State the formula for the fixed income ETFs' premium/discount and describe each of its three components.

(g) (*1.5 points*) Assess advantages and disadvantages of using fixed income ETFs rather than futures contracts to adjust duration of a portfolio.

(h) (*1 point*) Assess the impact on liquidity and creation cost of a fixed income ETF if bid/offer spread of underlying securities widen. Justify your answer.

13. (*5 points*) Par yield curve is a curve constructed for theoretical bonds whose prices equal par (100).

(a) (*0.5 points*) Define zero-coupon spot curve and implied forward curve.

The following yield curves are given for semi-annual coupon nominal US Treasury bonds:

Time (year)	0.5	1.0	1.5	2.0
Par Yield (Yield-to-maturity)	3.0%	2.8%	2.6%	2.4%
Zero-Coupon Spot Rate (Annual Effective)	3.023%	2.818%	?	?

(b) (*1.5 points*) Calculate 2-year spot rate, using the information given above.

(c) (*0.5 point*) Calculate 1-year forward 1-year rate.

You are considering entering a 6-month repurchase agreement (repo) of your 10-year zero-coupon Treasury bond of market value currently at $10 million.

(d) (*0.5 point*) Calculate the repurchase price at which you will buy back.

(e) (*0.5 point*) Describe your interest rate exposure to the 10-year rate change under this repo agreement.

The following yield curve is given for semi-annual coupon TIPS (Treasury Inflation-Protected Securities):

Time (year)	0.5	1.0	1.5	2.0
Zero-Coupon Spot Rate (Annual Effective)	1.05%	0.95%	0.85%	0.75%

(f) (*1.5 points*)

(i) Calculate break-even annualized inflation rates for 1-year and 2-year periods.

(ii) Assess the market expected inflation rate over the next 2 years based on the calculation in part (f)(i). Justify your answer.

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14. (*7 points*) You are an investment consultant hired to help Company XYZ better manage their equity portfolio. XYZ maintains a core-satellite approach, with a broad market index and four specialty active managers.

(a) (*1 point*) Explain the merits of a core-satellite approach.

(b) (*2 points*) Describe the primary focuses, advantages, and major risks of the following styles of active equity investment.

(i) Growth

(ii) Market Oriented (Core or Blend)

(iii) Market Capitalization

(iv) Liquidity

(c) (*1.5 points*) Compare returns-based, holdings-based, and the style box approach to determining style.

One of the active managers for XYZ, Active Manager X, does not have a declared style. Holdings-based analysis of his portfolio is shown below:

	Active Manager X	Market Benchmark
Number of Stocks	50	500
Total Market Capitalization	$2 trillion	$10 trillion
P/E Ratio	28.3	21.70
Dividend Yield	1.67%	2.04%
P/B Ratio	3.67	2.82
EPS Growth (1 Yr Est)	2.9%	3.0%
Annual Turnover	15.0%	4.0%
Sector Weightings:		
Finance	25%	20%
Utilities	10%	5%
Info Technology	20%	25%
Health Care	15%	20%
Energy	10%	15%
Consumer Staples	20%	15%

(d) (*1.5 points*) Assess the Manager X's style.

14. Continued

(e) (*1 point*) Manager X has recently started practicing socially responsible investing (SRI).

(i) Explain how SRI may have an impact on Active Manager X's style.

(ii) Explain the benefits to monitoring potential style bias arising from SRI screens.

15. (*8 points*) You are a consultant for a publicly trading manufacturing company EFG. You are tasked with writing an Investment Policy Statement (IPS) for the company's Defined Benefit (DB) pension plan, given the following information.

- EFG is in a declining industry and its earnings are falling.
- EFG has a high debt to equity ratio.
- The DB Plan has a small surplus.
- The assets of the DB Plan are 5 times larger than the market capitalization of EFG.
- The average age of EFG's workforce is 50.
- The liabilities for active lives represent 30% of the total liabilities.
- The DB Plan provides generous subsidies on early retirement.

(a) (*1 point*) Propose risk objectives for the DB Plan.

(b) (*1.5 points*) Assess the DB Plan's risk tolerance.

(c) (*1 point*) Propose a return objective for the DB Plan.

(d) (*1.5 points*) Identify the following IPS elements for the DB Plan:

(i) Liquidity requirements

(ii) Time Horizon

(iii) Tax Concerns

(iv) Legal and Regulatory Requirements

(v) Unique Circumstances

To assist EFG in setting the asset mix policy for the DB Plan, you incorporate the latest iteration of liability-driven investing (LDI). Instead of constructing the liability-hedging portfolio separately from the return-seeking portfolio, you use granular risk factors to bind all of the exposures together in a single, unified portfolio.

(e) (*1 point*) Explain the benefits of your approach.

(f) (*1 point*) Propose how a portfolio for the DB Plan could look like, expressed using the risk factors.

15. Continued

EFG also sponsors a Defined Contribution (DC) pension plan for one group of its employees. The investments in the DC Plan are participant directed.

(g) (*1 point*) Identify specific elements of the DC Plan IPS that distinguish it from the DB Plan IPS.

****END OF EXAMINATION****
Afternoon Session

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