CASUALTY ACTUARIAL SOCIETY
AND THE
CANADIAN INSTITUTE OF ACTUARIES

May 5, 2011

Exam 9

Financial Risk and Rate of Return

3 HOURS

INSTRUCTIONS TO CANDIDATES

1. This 46.75 point examination consists of 21 problem and essay questions.

2. For the problem and essay questions, the number of points for each full question and part of a question is indicated at the beginning of the question or part. Answer these questions on the lined sheets provided in your Examination Envelope. Use dark pencil or ink. Do not use multiple colors.

   - Write your Candidate ID number and the examination number, 9, at the top of each answer sheet. Your name, or any other identifying mark, must not appear.
   - Do not answer more than one question on a single sheet of paper. Write only on the front lined side of the paper – **DO NOT WRITE ON THE BACK OF THE PAPER**. Be careful to give the number of the question you are answering on each sheet. If your response cannot be confined to one page, please use additional sheets of paper as necessary. Clearly mark the question number on each page of the response in addition to using a label such as "Page 1 of 2" on the first sheet of paper and then "Page 2 of 2" on the second sheet of paper.
   - The answer should be concise and confined to the question as posed. When a specified number of items are requested, do not offer more items than requested. For example, if you are requested to provide three items, only the first three responses will be graded.
   - In order to receive full credit or to maximize partial credit on mathematical and computational questions, you must clearly outline your approach in either verbal or mathematical form, showing calculations where necessary. Also, you must clearly specify any additional assumptions you have made to answer the question.

3. Do all problems until you reach the last page of the examination where "END OF EXAMINATION" is marked.

CONTINUE TO NEXT PAGE OF INSTRUCTIONS

4. Prior to the start of the exam, you will have a **fifteen-minute reading period** in which you can silently read the questions and check the exam booklet for missing or defective pages. A chart indicating the point value for each question is attached to the back of the examination. Writing will NOT be permitted during this time and you will not be permitted to hold pens or pencils. You will also not be allowed to use calculators. The supervisor has additional exams for those candidates who have defective exam booklets.

   - Verify that the table of the Normal Distribution is attached to the examination after the last question.

5. Your Examination Envelope is pre-labeled with your Candidate ID number, name, exam number and test center. Do not remove this label. Keep a record of your Candidate ID number for future inquiries regarding this exam.

6. Candidates must remain in the examination center until two hours after the start of the examination. The examination starts after the reading period is complete. You may leave the examination room to use the restroom with permission from the supervisor. To avoid excessive noise during the end of the examination, candidates may not leave the exam room during the last fifteen minutes of the examination.

7. At the end of the examination, place all answer sheets in the Examination Envelope. Please insert your answer sheets in your envelope in question number order. Insert a numbered page for each question, even if you have not attempted to answer that question. Nothing written in the examination booklet will be graded. Only the answer sheets will be graded. Also place any included reference materials in the Examination Envelope. BEFORE YOU TURN THE EXAMINATION ENVELOPE IN TO THE SUPERVISOR, BE SURE TO SIGN IT IN THE SPACE PROVIDED ABOVE THE CUT-OUT WINDOW.

8. If you have brought a self-addressed, stamped envelope, you may put the examination booklet and scrap paper inside and submit it separately to the supervisor. It will be mailed to you. Do not put the self-addressed stamped envelope inside the Examination Envelope.

   If you do not have a self-addressed, stamped envelope, please place the examination booklet in the Examination Envelope and seal the envelope. You may not take it with you. Do not put scrap paper in the Examination Envelope. The supervisor will collect your scrap paper.

   Candidates may obtain a copy of the examination from the CAS Web Site.

   All extra answer sheets, scrap paper, etc. must be returned to the supervisor for disposal.

9. Candidates must not give or receive assistance of any kind during the examination. Any cheating, any attempt to cheat, assisting others to cheat, or participating therein, or other improper conduct will result in the Casualty Actuarial Society and the Canadian Institute of Actuaries disqualifying the candidate's paper, and such other disciplinary action as may be deemed appropriate within the guidelines of the CAS Policy on Examination Discipline.

10. The exam survey is available on the CAS Web Site in the "Admissions/Exams" section. Please submit your survey by May 23, 2011.

END OF INSTRUCTIONS

1. (2.25 points)

A portfolio is being constructed for an investor using the following assets and assumptions:

	Asset		
	D	E	F
Expected Return	0.12	0.14	0.04
Standard Deviation	0.15	0.10	0.00

- The utility function is $U = E(r_c) - 0.5A\sigma_c^2$.
    - The subscript c refers to the optimal portfolio.
- The coefficient of risk aversion, A, is 7.
- The weight given to asset D in the optimal risky portfolio is 0.16.
- The reward-to-volatility ratio is 1.03.
- The investor is allowed to borrow at the risk-free rate.

a. (1.75 points)

Calculate the share of the optimal complete portfolio invested in the risk-free asset that would maximize the investor's utility.

b. (0.5 point)

Describe the result in part a above in terms of the optimal risky portfolio.

CONTINUED ON NEXT PAGE

2. (1.5 points)

   a. (0.5 point)

      Describe the arbitrage argument for restoring equilibrium prices.

   b. (0.5 point)

      Describe the risk-return dominance argument for restoring equilibrium prices.

   c. (0.5 point)

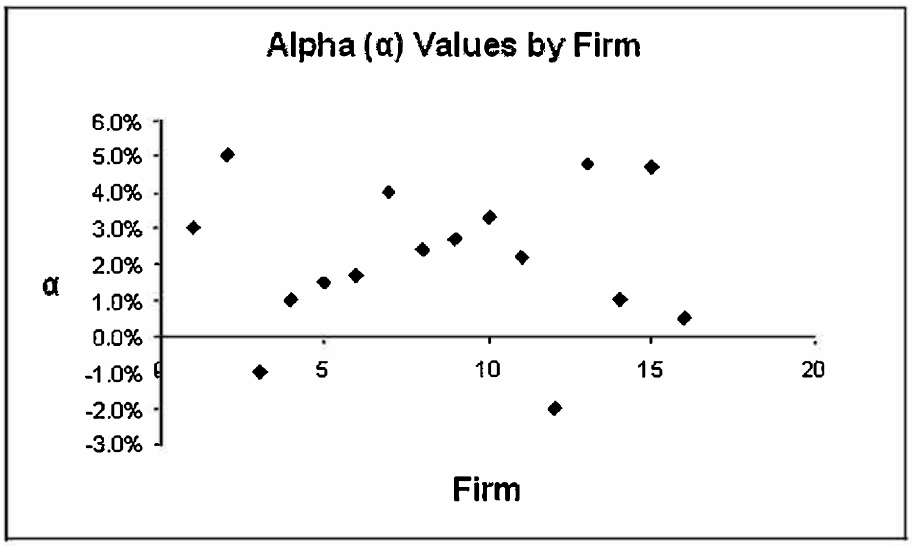
      Describe the main difference between the two arguments in parts a and b above.

CONTINUED ON NEXT PAGE

3. (0.75 point)

Given the following information:

- An index model of the following form is being used: $R_i = \alpha_i + \beta_i R_M + e_i$.
    - R_i is the return above the risk-free rate for firm i.
    - R_M is the return above the risk-free rate for the market.
- This index model was estimated for several firms using the above equation as a regression equation.
- The residual plot from this regression is shown in the following graph:



Explain whether or not this residual plot is consistent with expectations under the Capital Asset Pricing Model (CAPM).

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4. (1.5 points)

Assume that the simple Capital Asset Pricing Model (CAPM) is valid.

a. (0.75 point)

Evaluate whether Portfolio A below is consistent with CAPM.

Portfolio	Expected Return	Variance
Risk-free	0.08	0
Market	0.17	.05
A	0.14	.01

b. (0.75 point)

Evaluate whether Portfolio B below is consistent with CAPM.

Portfolio	Expected Return	Beta
Risk-free	0.07	0
Market	0.16	1.0
B	0.22	1.8

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5. (2.25 points)

An investor is using Security A and Security B to fund a financial obligation of $1,000,000 due in seven years.

Given the following information:

- Security A is a newly issued four-year bond with $1,000 par value.
    - Coupon payments are made annually.
    - The coupon rate on this bond is 5.0%.
- Security B is a perpetuity that pays $100 annually.
- Both Security A and Security B have an annual effective yield of 6.5%, compounded annually.

a. (1.75 points)

Calculate the amounts that should be invested in each of Security A and Security B in order to immunize the obligation from interest rate fluctuations.

b. (0.5 point)

Briefly describe two practical limitations to the immunization method in part a above.

CONTINUED ON NEXT PAGE

6. (1.25 points)

An insurance company has only the following items in its balance sheet.

Description	Statutory Book Value	Market Value	Duration
Money market	\$5,000	\$5,000	1.0
Stocks	\$37,000	\$37,000	19.0
Bonds	\$42,000	\$38,000	8.0
Loss Reserves	\$30,000	\$24,000	6.0

Calculate the duration gap of economic leverage for the company.

CONTINUED ON NEXT PAGE

7. (1.25 points)

Given the following information:

- A liability that needs to be paid in 14 years has the following characteristics:
    - The modified duration is 13.1.
    - The convexity is 183.4.
- Bond A is a 30-year bond that has annual coupon payments of 5.5% with a yield to maturity of 7%.
    - The modified duration is 13.0.
    - The convexity is 268.8.
- Bond B is a 15-year bond that has annual coupon payments of 2.5% with a yield to maturity of 2%.
    - The modified duration is 12.5.
    - The convexity is 185.6.

a. (0.5 point)

Calculate the approximate percent change in the price of Bond A, using the above modified duration and convexity, if the yield to maturity increases to 8%.

b. (0.25 point)

Briefly describe which of the two bonds above should be used to manage the interest rate risk of the liability that needs to be repaid.

c. (0.25 point)

Briefly describe the optimal strategy, given no constraints, for immunizing the liability.

d. (0.25 point)

Briefly describe the practical limitations for the strategy identified in part c above.

CONTINUED ON NEXT PAGE

8. (0.75 points)

   a. (0.5 point)

      Explain how a change in interest rates affects the modified duration of a bond.

   b. (0.25 point)

      Briefly explain one reason an investor may prefer bonds with higher convexity.

CONTINUED ON NEXT PAGE

9. (3 points)

Given the following information:

- Bond A has the following characteristics:
    - The par value is $1,000.
    - The term is two years.
    - The yield is 6% per annum, continuously compounded.
    - The recovery rate is 20%.

- Bond B has the following characteristics:
    - The par value is $1,000.
    - The term is three years.
    - The recovery rate is 20%.

- Default is possible only at the end of each year.

- The unconditional default rate is constant for years one and two and is the same for both bonds.

- The unconditional default rate for year three is 2%.

- The yield on similar risk-free bonds is 5% per annum, continuously compounded for both maturities.

Calculate the implied per annum, continuously compounded yield of Bond B.

CONTINUED ON NEXT PAGE

10. (3 points)

a. (1.5 points)

Identify and briefly describe three clauses that can be used for credit risk mitigation.

b. (1.5 points)

Describe one limitation for each clause in part a above.

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11. (1.5 points)

Fully explain the differences between Value at Risk and Expected Policyholder Deficit, including a description of how these metrics may be used to drive decisions regarding the capital levels for a company.

CONTINUED ON NEXT PAGE

12. (3.75 points)

a. (1.75 points)

Delineate the financial transactions that take place between the following counterparties to a CAT bond with a single-purpose reinsurer:

- Insurer
- Single-purpose reinsurer
- Investors
- Trust account

b. (1 point)

CAT bonds are often issued to cover high layers of reinsurance protection.

Describe two reasons CAT bonds may be more suited than traditional reinsurance for these high layers of protection.

c. (1 point)

Describe two reasons why Cat-E-Puts have not been as popular as CAT bonds in the marketplace.

CONTINUED ON NEXT PAGE

13. (2.5 points)

An insurer uses a risk-adjusted return on capital (RAROC) framework to evaluate its pricing adequacy for a given line of business. Given the following information about the line of business:

• Discounted expected losses & LAE	$60,000,000
• Undiscounted expected losses & LAE	$64,000,000
• Expense ratio	30%
• Total investment return	8%
• Target risk-adjusted return on capital	15%
• Allocated capital to the line	$20,000,000

- All premium and expenses are collected and paid at the beginning of the year.
- Losses are paid at the end of the year.

a. (1.5 points)

Determine the combined ratio the insurer would need to achieve for this line in order to meet its RAROC target.

b. (1 point)

The underwriting results of this line are highly correlated with other business units within the insurer. Capital was allocated to the business units using a proportional allocation method.

Fully explain whether the target combined ratio from part a above would likely be higher or lower if capital were allocated based on the Merton-Perold methodology.

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14. (1 point)

An insurer has set a target return on capital of 12%. A prospective risk requires multiple years of capital investment. The capital allocated to the risk runs off at the end of each year according to the following schedule:

Year	Capital Released
1	30%
2	40%
3	20%
4	10%

The insurer determines it needs to allocate $500,000 of initial capital to support the risk.

The insurer earns 7% interest income on the risk capital held each year.

Calculate the required economic profit that must be earned from the risk in order to meet the insurer's required return on capital.

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15. (2.75 points)

Given the following information (in millions):

Total assets	$120
Statutory capital and surplus	$40
Equity in unearned premium reserve	$11
Underwriting gain/loss (after-tax)	-$5
Investment income (after-tax)	$6
Earned premium	$60

a. (0.25 point)

Briefly explain what the insurance leverage factor measures.

b. (0.75 point)

Calculate the insurance leverage factor.

c. (0.25 point)

Briefly explain what the insurance exposure measures.

d. (0.5 point)

Calculate the insurance exposure.

e. (1 point)

Use the results from parts b and d above to calculate the total return on equity.

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16. (2 points)

a. (0.5 point)

Explain a disadvantage associated with the allocation of risk-based capital by line or by geography.

b. (1 point)

Briefly describe four sources of risk in the context of risk-based capital.

c. (0.5 point)

Describe one criterion used to test whether a rate of return is fair and reasonable for a regulated industry.

CONTINUED ON NEXT PAGE

17. (3 points)

Given the following information for accounts XYZ and ABC:

	XYZ Losses	ABC Losses	Combined Losses
Year 1	$2,000	$4,000	$6,000
Year 2	$3,000	$6,000	$9,000
Average	$2,500	$5,000	$7,500
Variance	250,000	1,000,000	2,250,000

The reinsurance load for the combined portfolio is $10,000.

a. (1.5 points)

Use the variance-based Shapley Method to calculate the reinsurance risk loads for each of accounts XYZ and ABC. For simplicity, use the given population variance, not the sample variance.

b. (1.5 points)

Use the covariance share method to calculate the reinsurance risk loads for each of accounts XYZ and ABC. For simplicity, use the given population variance, not the sample variance.

CONTINUED ON NEXT PAGE

18. (4 points)

An insurance company is analyzing a policy for the upcoming policy period. Given the following information:

- The policy is in force for one year.
- Premium is collected at the beginning of the policy period.
- Losses are paid according to the following schedule:
    - Year 1 $40,000
    - Year 2 $35,000
    - Year 3 $30,000
    - All losses are paid at the end of the respective years.
- At the beginning of the policy period $100,000 of capital must be committed and will be released at the end of year three.
- Unearned premium and loss reserves are held on the following schedule:
    - 100% of the policy premium value is held throughout year one.
    - 50% of the policy premium value is held throughout year two.
    - 25% of the policy premium value is held throughout year three.
- A 5% annual return is earned on investment of the capital and reserves.
- Investment income is earned at the end of a given year.
- An administrative expense equal to 15% of the policy premium is incurred at the beginning of the policy period.
- A tax rate of 35% applies to all income. Tax savings due to losses in a given period can be counted as an asset.
- For underwriting income purposes, assume the policy premium is earned in full by the end of year one.

Calculate the premium the insurance company must charge in order to meet its goal of a 15% internal rate of return on this policy.

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19. (2.5 points)

An insurance company writes two lines of business, and wants to determine which line is more profitable. Given the following information for the two lines of business:

	Premium	Reserves	Expected Loss Ratio	Expense Ratio	Average Time of Claim Payment
Line A	$200,000	$125,000	0.70	0.25	2 years
Line B	$100,000	$90,000	0.75	0.20	4.5 years

- The policy period is for one year.
- All premium is collected at the beginning of the policy period.
- All expenses are paid at the beginning of the policy period.
- The average time of claim payment is relative to the beginning of the policy period.
- The reserves include both loss and unearned premium reserves.
- The total amount of capital held by the insurance company is $550,000.
- Ignore investment income and taxes.

a. (1 point)

Calculate the internal rate of return for Line A if capital is allocated by line of business based on reserves.

b. (1 point)

Calculate the internal rate of return for Line A if the capital is allocated by line of business based on premium.

c. (0.5 point)

Briefly describe two reasons why the premium-based allocation scenario and the reserves-based allocation scenario may provide different answers regarding which line has a higher internal rate of return.

CONTINUED ON NEXT PAGE

20. (2.75 points)

Given the following information for an insurance company's financial results for the most recent calendar year:

- Tax rate on underwriting income = 34.0%
- Target return on equity = 15.0%
- After tax return on invested assets = 5.5%
- Calendar year earned premium = $100,000
- Equity-to-premium ratio = 0.6
- Surplus-to-premium ratio = 0.3
- Permissible loss ratio = 65.0%
- Average premium receivable = $15,000
- Prepaid acquisition expense ratio = 25.0%
- Unearned premium reserve = $30,000
- Ratio of loss reserve to incurred loss = 0.5

a. (2 points)

Use the calendar year return on equity method to calculate the underwriting profit provision.

b. (0.5 point)

Briefly describe one advantage and one disadvantage of using the calendar year return on equity method.

c. (0.25 point)

Identify another method to address the disadvantage noted in part b above.

CONTINUED ON NEXT PAGE

21. (3.5 points)

An insurer uses the present value offset method to compute the underwriting profit provision for a set of automobile liability policies.

Given the following information:

- Present value of losses per policy = \$60.
- Fixed expenses per policy = \$25.
- Variable expense ratio = 20%.
- Underwriting profit provision for homeowners = 5%.
- Interest rate for discounting losses = 2% compounded annually.
- Loss payout patterns:

Year	Homeowners	Auto Liability
1	40%	25%
2	30%	30%
3	30%	35%
4		10%

- Homeowners is considered the short-tailed reference line of business.
- All losses are paid out at the end of each year.

a. (3 points)

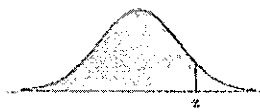
Calculate the expected combined ratio for this set of auto liability policies.

b. (0.5 point)

Briefly describe two advantages of the present value offset method compared to other methods.

END OF EXAMINATION

Tables of the Normal Distribution



Probability Content from -∞ to Z

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Values of z for selected values of Pr(Z<z)

z	0.842	1.036	1.282	1.645	1.960	2.326	2.576
Pr(Z<z)	0.800	0.850	0.900	0.950	0.975	0.990	0.995

Exam 9
Financial Risk and Rate of Return

May 5, 2011

POINT VALUE OF QUESTIONS

QUESTION	TOTAL POINT VALUE OF QUESTON	SUB-PART OF QUESTION (a)	(b)	(c)	(d)	(e)	(f)	(g)
1	2.25	1.75	0.50					
2	1.50	0.50	0.50	0.50				
3	0.75	0.75						
4	1.50	0.75	0.75					
5	2.25	1.75	0.50					
6	1.25	1.25						
7	1.25	0.50	0.25	0.25	0.25			
8	0.75	0.50	0.25					
9	3.00	3.00						
10	3.00	1.50	1.50					
11	1.50	1.50						
12	3.75	1.75	1.00	1.00				
13	2.50	1.50	1.00					
14	1.00	1.00						
15	2.75	0.25	0.75	0.25	0.50	1.00		
16	2.00	0.50	1.00	0.50				
17	3.00	1.50	1.50					
18	4.00	4.00						
19	2.50	1.00	1.00	0.50				
20	2.75	2.00	0.50	0.25				
21	3.50	3.00	0.50					
TOTAL	46.75							

<u>Question 1:</u>

Solution 1:
a)
r_f = .04 (Asset F)
W_D = .16 , W_E = 1-W_D = .84
E (r_p) = .16(.12)+.84(.14) = 13.68%
$E(r_p)$-r_f / σ_p = (.1368-.04)/σ_p = 1.03
1.03σ_p = .0968
σp= .094
y^* = $E(r_p)$-r_f / Aσ^2 = .1368 - .04 / 7(.094)^2 = 156.5% risky portfolio
position in risk-free= 1-1.565 = $\boxed{-56.5\%}$

b)
The optimal complete portfolio requires more invested in the optimal risky portfolio than the investor has, so the investor must borrow funds at the risk-free rate which will then be invested in the optimal risky portfolio.

Solution 2:
a)
For optimal risky portfolio c_p
W_D = 0.16 , W_E = 1- W_D = .84
R_D = 0.12 – 0.04 = 0.08 σ_D = 0.15
R_E = .14 – 0.04 = 0.1 σ_E = 0.1
We know W_D = 0.16 = 0.08*.01^2 – 0.1*σ_{DE} / 0.08*0.1^2 + 0.1*(0.15)^2- (0.08+0.1)* σ_{12}
➔ 0.000488 – 0.0288812 = 0.0008 - .01* σ_{12}
$\boxed{\sigma_{12} = 0.004382}$ = covcrd, rel
σp^2 = 0.15^2*(0.16)^2 + (0.1)^2*(0.84)^2
+ 2*0.16*0.84*0.004382
= 0.0088 → σ_p = 0.094
Y_p* = Rp / A σp^2 = (Rp/ σp) / A σp = S / A σp = 1.03 / 7*0.094
= 1.565
1 – 1.565 = $\boxed{-0.565}$ ← Answer weight on risk free of complete portfolio

b)
It means we should borrow risk free asset and invest in risky portfolio.

Solution 3:
a)
U = E (r_c) – 0.5A σ_c^2 = r_f + y[$E(r_p)$-r_f] - .5Ay^2 σp^2
Y = σc / σp or the allocation of the risky portfolio
dU/dy = $E(r_p)$ – r_f - A σp^{2}y = 0 to maximize y; y = $E(r_p)$ – r_f / A σp^2
= $E(r_p)$ – r_f / 7 σ_p^2 Reward to volatility ratio (assuming this means the risky portfolio) = E (r_p) – r_f / σp = 1.03
$E(r_p)$ = .16(.12)+.84(.14) = .1368
r_f = .04

$\sigma^2(p) = .16^2(.15)^2+.84^2(.1)^2+2(2/6)(.84)(.00438) = .00881$ *illegible* by .0939
$.16 = W_p = RP_D\,(\sigma_E^2) – RP_E\,Cov(D, E) / RP_\sigma\,(\sigma E^2) + RP_E(\sigma_D^2) – (RP_D+RP_E)\,Cov(D,E)$
$= .08(.1)^2-.1\,Cov(D,E) / .08(.1)^2+.1(.15^2)-.18\,Cov(D,E)$
“RP”= risk premium over risk-free rate
→ .16 = .0008 - .1 Cov (D,E) / .0008 + .00225-.18Cov(D,E)
= .0008-.1Cov(D,E) / .00305- .18 Cov(D,E)
.000488 - .0288Cov(D,E) = .0008 - .1Cov(D,E)
.712Cov(D,E) = .000312 Cov(D,E) = .00438
Y = .1368-.04 / 7 (.00881) = $\boxed{1.5696}$
The investor should <u>borrow</u> @ the risk-free rate (57%) and invest 100% in the risky portfolio

b)
Borrow @ the risk-free rate and invest in the optimal risky portfolio. The final weights on the complete portfolio are: D – 25%, E – 132%, F- (-57%)

Solution 4:
a)
$r_f = .04$ (asset F)
must find ρ_{DE}
$W_D = (E(r_p)–r_f)\sigma_E^2-(E(r_E)-r_f)\sigma_D\sigma_E\rho / (E(r_D+r_f)\sigma_E^2+(E(r_E)–r_f))\sigma_D^2 –(E(r_D)–r_f+E(r_E)-r_f)\sigma_D\sigma_E\rho$
→ $.16 = (.12-.04).10^2-(.14-.04)(.15)(.10)\rho / (0.12-.04).10^2+(.14-.04).15^2-(.14-.04+.12-.04)(.15)(.10)\rho$
$.16 = .0008-.0015\rho / .00305-.0027\rho$
$.000488-.000432\rho = .0008-.0015\rho$
$\rho = .292$
→ $E(r_p)\ W_DE(r_D)+W_EE(r_E)$
= .16(.12)+.84(.14)=.1368
$\sigma_p^2 = W_D^2\ \sigma_D^2+W_E^2\ \sigma_E^2+2W_DW_E\ \sigma_D\ \sigma_E\rho$
$= .16^2(.15)^2+.84^2.10^2+2(.16)(.84)(.15)(.10)(.292)$
=.00881
$Y^* = E(r_p)-r_f / A\ \sigma_p^2 = .1368-.04 / 7\ (.00881) = \boxed{1.570}$ (risky) → $\boxed{1-y^* = -.57}$ (risk–free)

b)
Borrow \$.57 for every dollar to invest \$1.57 in risky assets.

Solution 5:
a)
W_D in optional risky portfolio = .16 therefore W_E = 1-1.6=.84
Let P be he optional risky portfolio
$E(r_p) = (0.16)(0.12)+(.84)(.14)$
=.1368
Asset F is the risk-free asset so $r_E = .04$
$E(r_p)-r_E / \sigma_p$ = reward to volatility ratio = 1.03= sharpe ratio
$E(r_p) = r_f+[ED(r_p)-r_f]\ \sigma_C / \sigma_p$
$E(r_C) = .04+1.03\ \sigma_C$ → substitute into → $U = E(r_C)-0.5A\ \sigma_C^2$
$U = .04 +1.03\ \sigma_C-3.5\ \sigma_C^2$

In order to maximize U take 1st derivative in relation to σ_C & set to 0 and solve for σ_C
$0 = 1.03-7\ \sigma_C$
$.147143 = \sigma \rightarrow$ plug into equation from above
$E(r_C) = .04+1.03(.147143)$
$E(r_C) = .191557$ $E(r_p)$
$.191557 = (1-W_f(r_f)$
W_f = weight of complete optimal portfolio invested in risk-free asset
$.191557 = (1-W_f)E(r_p)+W_E r_f$
$.191557 = (1-W_f).1368+W_E(.04)$
$.191557 = .1368-.1368W_f+.04W_f$
$0.054707 = -.0968W_f$
$-.56567=W_f$
The investor's utility is not maximized by investing in the risk free asset at all instead the optimal complete portfolio consists of borrowing an additional 56.57% (of the amount being invested) at the risk free rate & using the borrowed funds to purchase more of the optional risky portfolio.

b)
The investor should invest 156.57% of their funds in the optimal risky portfolio, borrowing the additional 56.57% at the risk-free rate.

Solution 6:
a)
$E(r_C) = yE(r_p)+(1-y)\ r_f$ $E(r_E) = 0.14$ $E(r_D) = 0.12$ $W_p = 0.16$
$\sigma_C = y\ \sigma p$
$E(r_p) = W_D E(r_D)+(1-W_D)E(r_E) = 0.1368$
$\sigma\ p^2 = W^2\ \sigma_D^2 +(1-W)^2\ \sigma_E^2+2\rho w(1-W)\ \sigma_p\ \sigma_E$ (Where ρ is unknown)
$y = E(r_p)-r_f / A\ \sigma_p^2$ $E(r_C)-r_f / \sigma_C = 1.03$
$[yE(r_p)+(1-y)r_f]-r_f / y\ \sigma_p = 1.03$
$Y[E(r_p)-r_f] / y\ \sigma_p = 1.03$
$[E(r_p)-r_f]^2 / \sigma_p^2 = 1.03^2$
$Y = 1.03^2 / A(E(r_p)-r_f) = 1.03^2 / 7\ (0.1368-0.04) = 1.56$
$1\text{-}y$ = weight to risk-free = $\boxed{-56\%}$ (i.e. borrowing this)

b)
The investor would borrow 56% of their invested amount, then invest their own assets, plus this borrowing, the optimal risky portfolio.

Solution 7:
a)
$E(r_p) = 0.16(0.12)+0.84(0.14) = 0.1368$
$S= 0.1368-0.04 / 7(0.094)^2 = 1.5657$
Portion invested in risk free asset is -0.5657 (borrow -.5657 at risk-free rate)

b)
25.05% will be invested in D

131.52% will be invested in E
These two items form the optimal risky portfolio.
(-.5657 will be borrowed at risk free rate)

Question 2

a) The arbitrage argument states that when a security is mispriced a few investors will make large changes to their portfolio by buying or selling the mispriced security (depending whether the mispriced security is underpriced or overpriced.) This will very quickly restore equilibrium.
b) The risk return dominance argument states that when a security is mispriced many investors will make small changes to tilt the portfolio toward the mispriced security. The cumulative results of all these investors' actions will restore the equilibrium.
c) In part A, it is the fast actions of just a few investors that restore equilibrium. Part A reflects large changes made by a few investors. Part B is based on the small actions of many investors which restores equilibrium. Since the arbitrage argument relies on more severe portfolio changes by <u>fewer</u> investors the arbitrage argument is stronger.

Question 3

Solution 1:
Residuals indicate an average positive α, which is contrary to CAPM, CAPM theorizes that the average α will be zero. In fact it theorizes that all α is zero for <u>expected</u> returns. What actually happens may contain random variation, but for a large random sample α should still roughly average zero.

Solution 2:
This graph is inconsistent with CAPM. Under CAPM, $E(\alpha) = 0$ for all securities, so the plot of alpha values should center around 0. The graph shows that α is skewed to be positive.

Solution 3:
I would argue that this plot is inconsistent with CAPM assumptions. If we expect CAPM to hold
$r_i = r_f + B_i\ (r_n - r_i)$
Where $R_i = r_i - r_f = B_i\ (r_n - r_i) = B_i R_n$
Which means that $\alpha_i + e_i$ should be 0
However, there are many positive alphas with varying magnitude so I do not think the plot is consistent w/ CAPM assumptions.

Question 4

Part a:

Solution 1:

$S_m = .17 - .08 / \sqrt{.05} = .4025$

$S_A = .14\text{-}.08 / \sqrt{.01} = .6$
This is not consistent since CAPM says that the market portfolio is the best option. Sharpe ratio for stock A though is higher than for the market portfolio, meaning A is a better investment than the market and this is not possible under CAPM.

Solution 2:

$\sigma_i^2 = \beta_i^2\, \sigma_m^2 + \sigma_{Ei}^2$, $.01 = \beta_i^2(.05) + \sigma_{Ei}^2$, $\sigma_{Ei}^2 \geq 0$, $mcx\beta_i^2 = .2$, $\beta_i \leq .447$, $.14\text{-}.08 = .06 = \beta_i\,[.09]$, $\beta_i = 2/3 > .447$
Since the maximum beta for portfolio A is $B_A = .447$, this is not consistent with CAPM, as CAPM implies $B_A = 2/3$.

Solution 3:

$E(r_A) = .08 + \beta_A(.09) = .14?$
This implies that $\beta_A = 2/3$
$\beta_A = 2/3 = Cov(A,M) / Var(M) = Cov(A,M) / .05$
$.0333 = Cov(A,M)$
BUT $Cov(A,M) = \rho\sigma A\sigma M = \sqrt{.01}\sqrt{.05}\rho$
So $\rho = Cov(A,M) / \sqrt{.01.05} = 1.49$
But ρ must be between -1 and +1, inclusive.
***Inconsistent

Solution 4:

RF 0, M .22, A .1
Not consistent since A is above the CAL

Solution 5:

Not Consistent
$.22 = .07 + B(.16\text{-}.07)$
$B = 1.6667$
Which is not equal to stated B of 1.8
Therefore an arbitrage opportunity is available as the expectations for the portfolio are different than the stated return.

Part b:

$E[r_B] = r_f + \beta_B\,(E[r_m]\text{-}r_f)$ $.22 = \alpha_B + .232$ $= .07 + 1.8(.16\text{-}.07) = .232$ $\alpha_B = -.012$
But we are given $E[r_g] = .22$. Thus we have to conclude that $\alpha_B = -.012$, but CAPM says that α should be 0 for all stocks. Thus this is not consistent with CAPM.

Question 5

Part a:

Solution 1:

$D_A = 0.05*1000(1*1.065^{-1}+2*1.065^{-2}+3*1.065^{-3}+4*1.065^{-4} / 0.05*1000a_{4\surd6.5\%}+1000*1.065^{-4}$
$= 3.7149$
$D_B = 1+0.065/ 0.065 = 16.3846$
$P_A = 0.05*1000a_{4\surd6.5\%}+1000*1.065^{-4} \quad = \quad 948.61$
$P_B = 100 / 0.065 = 1538.46$
→ $D_L = W_AD_A+(1-W_A)D_B \quad D_L = 7$
$7 = 3.7149(W_A+16.3846-16.3846*W_A$
→ $W_A = 74.07\%$ → $W_B = 1- W_A = 25.93\%$
→ PV (liab) = $1,000,000*1.065^7 = 643,506.21$
→Amount to invest in A = W_A*PV(liab) = 476,654.87
→ Amouth to invest in B = W_B*PV(liab) = 166,851.35

Solution 2:

$D_A = P_- - P_+ / P*дy = 951.93-945.3 / 948.6*.001*2 = +3.4882$
$D_B = 1 / .65 = 15.3846$
$W_AD_A+W_BD_B = 7$
$W_A*3.4882+(1-W_A)*15.3846 = 7$
$W_A = .7048$
$W_B = .2952$
Total = IM $(1.065)^{-7} = 643,506.2$
A = 453,543.18
B = 189,963.03

Part b:

Solution 1:

1. Need to rebalance if interest rates change → durations change.
2. Need to rebalance with the passage of time → durations change.

Solution 2:

Will only be immunized for small parallel shifts in the yields curve – will need to rebalance as durations of assets + liab shift over time → transaction costs can add up.

<u>Question 6</u>

DGel = DMVS-DMVA = 15.5-12.65 = $\boxed{2.85}$

DMVS = DMVA* MVA-DMVL / MVS *MVL

MVA = 80

DMVA = 5(1)+37(19) / 80 +38(8) = 12.65

MVL = 24
DMVL = 6
MVS = 80 – 24 = 56

DMVS = 12.65(80)-6(24) / 56 = 15.5

<u>Question 7</u>

Part a:

$\Delta P / P = -D^{*}\Delta y + \frac{1}{2}\text{ convexity } (\Delta y)^2$
$= -13\ (0.01) + \frac{1}{2}(268.8)(0.01)^2$
$= -0.11656$

Part b:

Solution 1:
Bond A should be used to manage the interest rate risk of the liability because the modified duration of bond A is approximately the same as the modified duration of the liabilities.

Solution 2:
A one percent increase on bond B changes the prime by -11.57%

Solution 3:
The optimal strategy would be to purchase a zero coupon bong that matures in 14 years that will pay an amount equal to the liability.

Part c:

Optimal Strategy would be to immunize interest rate risk by cash flow matching the cash flows of the assets and liabilities.

Part d:

Solution 1:
This strategy would be:
a) Costly and time consuming in practice
b) It would be difficult to find assets/bonds that exactly match the cash flows of the liability.

Solution 2:
It's very expensive, cumbersome, and creates unnecessary volatility in earnings, and can unnecessarily force the company to give up investment income it could have earned otherwise.

Solution 3:

The strategy listed above is extremely difficult to implement because finding the appropriate assets is difficult and costly and limits types of assets which can be used (e.g. cannot take advantage of mispricing.) It can also cause volatility.

Solution 4:

Only good for small Δ's in interest rate, need to watch out for inflation impacts and the parallel shift in term structure.

Solution 5:

Net worth immunization with a convexity adjustment is only valid for parallel shifts in the yield above. Also, the asset portfolio will have to be rebalanced frequently as assets and liabilities' durations change differently with elapsing time and in response to interest rate changes.

Solution 6:

Need to continually rebalance because the duration of assets and liab's can change over time.
Only works for small changes in interest rates
Ignores inflation

Solution 7:

Contingent immunization only protects against nominal value of liability, ignored inflation.

Question 8:

Solution 1:

a) Interest rate up, then present value of distant payment will decrease more. So bigger portion of the present value is coming from earlier payments. So the duration will increase.
b) For the bond with high convexity, The increase in bond price due to a decrease in interest rate is bigger than decrease in price due to the same degree of interest rate increase.

Solution 2:

a) Modified duration is inversely related to interest rates. As interest rates increase, modified duration decreases and vice versa. This is because an increase in interest rates decreases the present value of the most distant payments more than the nearest ones.
b) Investors prefer bonds with higher convexity because they gain more in price when interest rates fall than they lose when interest rates rise.

Question 9

Solution 1:

For Bond A (assume bond A is a zero coupon bond since coupon rate not given):

t	**Risk-free value**	**PV of expected loss on default**	=
1	$1000e^{-0.05(1)} = 951.23$	$[951.233-0.2(1,000)]Qe^{-0.05(1)}$	714.59Q
2	1000	$[1000-0.2(1,000)]Qe^{-0.05(2)}$	723.87Q
			1,438.46Q

Assume default occurs immediately prior to repayment of par value.
Price of risk-free bond = $1,000e^{-0.06(2)} = 886.92$
→ Expected loss on default = 904.84 – 886.92 = 17.92
1,438.46Q = 17.92
Q = 0.01246

For Bond B (assume bond B is a zero coupon bond since coupon rate not given):

t	**Risk-free value**	**PV of expected lost on default**	=
1	$1000e^{-0.05(2)} = 904.84$	$[904.84-0.2(1000)]Qe^{-0.05(1)}$	8.354
2	$1000e^{-0.05(1)} = 951.23$	$[951.23-0.2(1000)]Qe^{-0.05(2)}$	8.4696
3	1000	$[1000-0.2(1000)]\ (0.02)e^{-0.05(3)}$	13.771
			30.5946

Assume default occurs immediately prior to repayment of par value.
Price of risk-free bond = $1000e^{-0.05(3)} = 860.71$
Price of bond B = $1000e^{-r(3)}$ (let r = continuously compounded yield of Bond B)
→ $860.71 – 1000e^{-3r} = 30.5946$
r = 0.06206

Solution 2:

Bond A: Q = prob of default.
$1000e^{-6\%*2} = 1000*20\%e^{-5\%*1}\ Q+1000*20\%e^{-5\%*2}\ Q+1000e^{-5\%*2}\ (1-2Q)$
886.92 = 190.25Q+180.97Q+904.84(1-2Q)
-17.92 = -1438.46Q
Q = 1.245777%

Bond B: $1000*20\%e^{-5\%*2}\ Q+1000*20\%e^{-5\%*3}*2\%$
$+1000e^{-5\%*3}(1-2Q-2\%)$
= 830.12
So $830.12 = 1000e^{-x*3}$ → x = 6.2062%

Solution 3:

A:

T	**Risk-free Val.**	**Recovery**	**LGD**	**Q**	**E(L)**
1	1068	200	868	Q	825.67Q
2	1060	200	860	Q	778.16Q

					1603.83Q

P(6%) = 996.64
P(5%) = 1016.20
1016.20-996.64 = 1603.83Q
Q = 1.22%
Assuming 6% coupon

B:

T	Risk-free val	Recovery	LGD	PV	Q	E(L)
1	1076	200	876	$e^{-.05}$	1.22%	10.17
2	1068	200	868	$e^{-.10}$	1.22%	9.58
3	1060	200	860	$e^{-.15}$	2%	14.80
						34.55

P(5%) = 1023.71
P(6%) = P(x) = 34.55
P(x) = 989.16
$P(x) = 60 / (1+x) + 60 / (1+x)^2 + 1060 / (1+x)^3$
X = 6.41% in calculator compound annually assuming 6% coupon $\boxed{6.21\%}$ continuously compounded.

Question 10:

Part a:

Netting: Forces a company to close out all contracts with an entity if the company wishes to default on a single contract

Collateralizations: States that if the value of all contracts with a single entity exceeds a given threshold, then that entity must post collateral for the value greater than the threshold

Credit downgrade trigger: Upon a credit downgrade, you have the option to close out any contracts with that company which was downgraded.

Part b:

Netting:

- Makes contracts difficult to value
- Tough to predict/build contracts which are 100% offsetting due to complexity of defaults/contracts
- Only works if there are liabilities to the counterparty held. If B only owes A, then A has no benefit from netting. Also protection only limited (will lose remaining value).
- There may be only one contract that counterparty with F.I. Also the effect of the netting clause depends on the correlation between these contracts. When they are all positively/perfectly correlated, then no reduction of risk.
- Netting may not matter if the counterparty cannot pay any of its obligations
- Protection is not total, only helps limit downside if default
- May not provide complete protection. Actually may not provide any protection if the liabilities only flow in one direction.

Collateralizations

- The entity may not respond to collateral calls if it is in financial distress
- The amount below the threshold is not collateralized which can be significant
- Collateral posted may lose value at the same time that the counterparty is facing financial distress ie mortgage CDOs.
- Other counterparties might have same clause and might cause a liquidity problem
- Requiring collateral does not guarantee that all extreme loss scenarios will be adequately covered and anticipated
- Collateralization is only helpful if not a lot of contracts call for it; otherwise the counterparty may not be able to provide the required collateralization.
- Exact amount of margin may be tough to collateralize in an acceptable format.
- The collateral requirements of too many agreements may themselves threaten the solvency of a company, if they are overused.
- May be difficult to always specify cash collateral. I.e. limit buyers. But if you accept a LOC from a bank, you then take on the bank's credit risk.
- Assets posted as collateral might be risky themselves
- The counterparty may go into distress so quickly that collateral may still not be collectible

Credit downgrade trigger

- Only effective if the company that's downgraded has only a few contracts with this clause.
- If counterparty is downgraded and other companies have downgrade triggers with counterparty, may not be able to pay market value on all contracts → may push into default.
- If counterparty has quick decrease in credit rating, may not be possible to close out transactions before counterparty defaults
- These may make it even more difficult for the counterparty to meet contract obligations because of their reduced ability to raise funds due to credit downgrade.

- Risk can still increase even when there is no downgrade

Question 11

Solution 1
Value at Risk is less concerned with severity of loss and more concerned with the threshold for a given ruin probability. It is the value we expect to exceed no more than x% of the time. EPD considers the average shortfall given a loss and provides an according capital requirement. As an example, consider 1000 simulations with the 10 highest liabilities as follows. Operating at the 99.5% VaR would require 500,000 in capital. Using EPD, however, would require capital to cover the expected deficit of 1.5M / 1000 = 1,500.

	E(L)	**Assets**	**EPD**
1000	1m	500,000	500k
999	900k		400k
8	800k		300k
7	700k		200k
6	600k		100k
5	500k		0
4	400k		0
3	300k		0
2	200k		0
1	100k		0

Solution 2:
1) VaR calculates the following: 'we are x% certain that losses will not exceed V in the next N days.' It tries to quantify the probability of lower tail outcomes. A company can use VaR to calculate an *exceedance* probability [P(L)E(L)+C] and allocate capital so that *exceedance* probabilities are equal among lines. It could be difficult to use VaR to allocate capital b/c the firm may not have enough capital to achieve an *exceedance* prob. Further VaR does not account for diversification or severity of a loss.
2) EPD calculated the expected value of the difference between the obligation owed to the claimant and the amount actually paid. EPD can be used to allocate capital by ensuring that the EPD ratios are equal among lines. (Make sure each line has enough capital to achieve a certain EPD) EPD accounts for the severity of a deficit but still does not account for the benefits of diversification.

Solution 3:
VaR Measures value of loss within a specified time horizon up to a specified prob. level. It's based on normal distribution assumption. It does consider frequency of severe situation, but it does not consider severity of loss when loss passed the threshold.
EPD measures expected deficit value where asset is not enough to cover liability. Both freq. and sev. are considered.
EPD= E(L-A / L>A) EPD is like tail expectation.
If there are two risks, each with same VaR, but loss from one risk is much more severe than the other, then VaR will allocate same capital to both, EPD will allocate more capital to the one have large amount of loss in the tail.

<u>Question 12:</u>

Part a:
Solution 1:
X+Libor: Test account to SPR
Principal: SPR to Test Account
Principal: Test account to SPR at maturing or if CAT event

Premium: *<u>Insurer</u>* to SPR
Principal: SPR to *<u>Insurer</u>* if CAT event

Principal: Investor to SPR
Libor: SPR to Investor
Premium + X: SPR to Investor
Principal: SPR to Investor if NO CAT event

X is a certain number of basis point

CAT Event: catastrophic event that pulls out the trigger

Solution 2:
The single purpose reinsurer sells a bond to investors, and invests the *(illegible*) in a highly rated investment for the amount of short-term assets.
The single purpose reinsurer collects premiums from the insurer and passes them to investors
The trust account pages investment payments from the invested assets to the to the single purpose reinsurer, who passes them to inventory.
Upon a CAT event, the single purpose disinvests received principal and passes it to the insurer.
Upon maturity, the single purpose reinsurer disinvests any remaining principal and returns it to inventory.

Part b:

Solution 1:
1) CAT bonds are fully collateralized so it avoids concerns with credit risk associated with reinsurance of high layers
2) CAT bonds have a lower spread because they offer diversification benefits for investors. They cost less than reinsurance in high layers.

Solution 2:
In traditional reinsurance, high layers require very high risk loads, however investors seek to diversify their risks and CAT losses are not very correlated with other market risks so it may be cheaper.

Part c:
1) They are not fully collateralized so exposed to credit risk.
2) Issuing preferred stocks may dilute the value of actual shares.

<u>Question 13:</u>

Part a:

Solution 1:

RAROC = [(Premium – Expenses) * (1 + Investment Return) – Discounted Loss & LAE] / [Allocated Risk Capital]

15% = [(Premium – 30%*Premium) * (1.08) – 60,000,000] / [20,000,000]
[15% * 20,000,000 + 60,000,000] / 1.08 = Premium * (1 – 30%)
Premium = 58,333,333 / .7
Premium = 83,333,333

Combined Ratio = (Undiscounted Losses & LAE + Expenses) / Premium
= (64,000,000 + 30% * Premium) / Premium

Combined Ratio = (64,000,000 + 30% * 83,333,333) / 83,333,333
= 106.8%

Solution 2:

RAROC = [(Premium – Expenses) * (1 + Investment Return) – Undiscounted Loss & LAE] / [Allocated Risk Capital]

15% = [(Premium – 30%*Premium) * (1.08) – 64,000,000] / [20,000,000]
[15% * 20,000,000 + 64,000,000] / 1.08 = Premium * (1 – 30%)
Premium = 62,037,037 / .7
Premium = 88,624,339

Combined Ratio = (Undiscounted Losses & LAE + Expenses) / Premium
= (64,000,000 + 30% * Premium) / Premium

Combined Ratio = (64,000,000 + 30% * 88,624,339) / 88,624,339
= 102.2%

Solution 3:

RAROC = [(Premium – Expenses) * (1 + Investment Return) + (Allocated Risk Capital * Investment Return)– Discounted Loss & LAE] / [Allocated Risk Capital]

15% = [(Premium – 30%*Premium) * (1.08) + (20,000,000 * 0.08) – 60,000,000] / [20,000,000]
[15% * 20,000,000 – 1,600,000 + 60,000,000] / 1.08 = Premium * (1 – 30%)
Premium = 56,851,852 / .7
Premium = 81,216,931

Combined Ratio = (Undiscounted Losses & LAE + Expenses) / Premium
= (64,000,000 + 30% * Premium) / Premium

Combined Ratio = (64,000,000 + 30% * 81,216,931) / 81,216,931
= 108.8%

Solution 4:

RAROC = [(Premium – Expenses) * (1 + Investment Return) + (Allocated Risk Capital * Investment Return)– Undiscounted Loss & LAE] / [Allocated Risk Capital]
15% = [(Premium – 30%*Premium) * (1.08) + (20,000,000 * 0.08) – 64,000,000] / [20,000,000]
[15% * 20,000,000 – 1,600,000 + 64,000,000] / 1.08 = Premium * (1 – 30%)
Premium = 60,555,556 / .7
Premium = 86,507,937

Combined Ratio = (Undiscounted Losses & LAE + Expenses) / Premium
= (64,000,000 + 30% * Premium) / Premium

Combined Ratio = (64,000,000 + 30% * 86,507,937) / 86,507,937
= 104.0%

Part b:

Solution 1:

Under the Merton-Perold approach, a highly correlated line of business will be allocated more capital.

The difference between the total firm capital and the capital excluding the line will be larger than if the line was a more diversifying exposure. The increase in allocated capital will result in a higher required premium to hit the target RAROC.

Therefore the target combined ratio will be lower.

Solution 2:

Under the Merton-Perold approach, it is possible that less than the entire firm’s capital is allocated across the lines of business.

The decrease in allocated capital will result in a lower required premium to hit the target RAROC.

Therefore the target combined ratio will be higher.

Question 14:

Solution 1:

R = .12

T	**C**
1	500,000
2	500,000-.3(500,000) = 350,000
3	350,000-.4(500,000) = 150,000
4	150,000-.2(500,000) = 50,000

Adg Target R = R [$\Sigma C_{i(Hr)}^{-1}$] / C_i
= .12 [500,000(1.07^{-1})+350,000(1.07^{-2})+150,000(1.07^{-3})+50000(1.07^{-4}) / 500,000]
= .12 (933.583 / 500,000) = .22406
Req economic profit = .224(500,000) = $\boxed{112,030}$

Solution 2:
Target = (.12) x $\Sigma C_i(1+r)^{-1}$ / C_1 = .12 (933.58/500k)

	(1)			(2)	(1) x (2)
	C_i	released	ending	DF	Discounted (capro)
1	500k	150k	350k	.9346	467.3k
2	350k	200k	150k	.8734	305.69k
3	150k	100k	50k	.8163	122.445k
4	50k	50k	0k	.7629	38.145
					933.59

EC Profit required = (.12)(933,580)
= $\boxed{112,029.6}$ ← Answer

Solution 3:

Yr	Cap	Req'd *(illegible)*	PU return
1	500k	500k x .12 = 60k	60/1.07 = 56.075
2	350k	42k	$42/1.07^2$ = 36.684
3	150k	18	14.693
4	50k	6	4.577
		126k	112.03k

Total profit in PU terms = 112.03 k

<u>Question 15:</u>

Solution 1:

- **a)** Insurance leverage factor = 1+ R/S → Measures the amount of leverage of reserves relative to surplus contribution
- **b)** 1+ R/S = 1+ 69/51 = 2.353 → S = Statutory capital & surplus + Equity in the UPR

= 40+ 11 = 51
R = A-S = 120-51 = 69

- **c)** Insurance exposure = P/S = Premium leverage factor relative to surplus amount of premium that can be written given supply level
- **d)** P/S = 60/51 = 1.176
- **e)** T/S = I/A(1+ (R/S)) + U/P x P/S = 6/120 (2.353)+ (-5)/60 x 1.176 = I+U/S = 6+(-5)/ 51 = 1.961%

Solution 2:

- **a)** The insurance leverage factor measures the amount of assets available to be invested and earn investment income. The reserves and surplus make up these investable assets. In ferram's equation par total return on surplus, the insurance leverage as a percentage of surplus = 1+ R/S where R= reserves and S = Surplus/
- **b)** 1+ R/S
  S = 40+11 = 51
  R = A-S = 120-51 = 69
  → 1+ R/S = 1 + 69/51 = $\boxed{2.35294}$
- **c)** The insurance exposure is the amount of premium as a percentage of surplus. This measures the amount of surplus that backs each dollar of premium written.
- **d)** P/S = 60/57 = $\boxed{1.17647}$
- **e)** T/S = I/A (1+R/S) + U/P (P/S)
  = 6/120 (2.35294) + -5/60 (1.17647) = $\boxed{1.961\%}$

Solution 3:

- **a)** It measures the ratio of total asset to surplus
- **b)** A = 120
  S = 40+11 = 51   R= A-S = 120 – 51 = 69
  So leverage factor = 1+ R/S = 1+ 69/51 = 2.35294
- **c)** The premium to surplus ratio
- **d)** P/S = 60/51 = 1.17647
- **e)** T/S = I/A (1+ R/S) +U/P (P/S) = 6/120 (1+ 69/51)+ (-5/60)*60/51 = 0.01961 = 1.961%

Solution 4:

- **a)** Amount of reserves and surplus in relation to surplus
- **b)** 1+R/S = 1+69/51 = 2.35   Resv (R) = Loss resv + UEPR – equity in UEPR
  S = Capital + surplus+ equity in UEPR = 40+11 = 51
  A = R+S → 120 = R + 51 or R = 69
- **c)** Amount of premium in relation to surplus
- **d)** P/S = 60/51 = 1.176
- **e)** I/S = I/A (1+ R/S) + U/P x P/S = 6/120 (1 + 69/51) + (-5/60) (60/51) = .0196

Solution 5:

- **a)** Ins. Leverage factor measures the current leverage of the insurer in terms of reserves over total equity. Reserves are similar to loans for insurer, and the magnitude of this leverage impacts the insurer's results, so it is important to monitor.

b) (1+ R/S)
A = R+S → 120 = R +(40+11)
R = 69
S = 40+11 = 51
(1+ R/S)2) 1+ 69/51 = $\boxed{2.353}$

c) Ins exposure measures the amount of premium to equity, which shows the amt. of business relative to the owner's equity. The owner's would want to monitor this to determine investment strategies if *(illegible)* is increasing while S remains constant, it means more risk for the owners, so a conservative investment strategy is needed.

d) P/S = 60/51 = $\boxed{1.1765}$

e) I/S = I/A(1+ R/S) + U/P x P/S
= 6/120 (1+69/51) + (-5/60) (60/51)
= .0196 → $\boxed{1.96\%}$

Solution 6:

a) Insurance leverage factor is used to measure the reserves to surplis (including equity in UEPR)

b) The insurance leverage factor = 1+ R/S = 1 + 69/51 = 2.3529
S = Statutory capital +surplus + equity in UEPR = 51
R= A-S = 120 – 51 = 69

c) Insurance exposure measures the premium to surplus.

d) Insurance exposure = P/S = 60/51 = 1.1764

e) T/S = underwriting gain/loss (after tax) + Investment income after tax/ S
= -5+6/51 = 0.0196

Solution 7:
A la Ferrari

a) Insurance leverage referst to capital held as a by-product of writing the business, in particular, this compares <u>Reserves</u> held to <u>Surplus</u>

b) The "insurance leverage factor" is cited as (1+ R/S)
Here$\boxed{:\ = (1 + 69/51) = 2.353}$
<u>Note:</u> We consider "S" as equity = statutory Cap/Surpl + Equity in UNEPR = 40+11 = 51
We infer Reserves from Assets = Surplus (Equity) + Reserves or 120 = 51+R → R = 69

c) Insurance exposure is the relationship between <u>current writings</u> and <u>surplus</u> or $\boxed{\text{PREM : SURPLUS}}$

d) Here, Insurance Exposure = P/S = <u>60/51 = 1.176</u>

e) From the full formula (1)
T/S = I/A (1 + R/S) + U/P(P/S)
= 6/120(2.353)+-5/60(1.176) = 0.0196 → <u>1.96%</u>

<u>**Question #: 16**</u>

Solution 1

A. All capital of the company supports the operation of the company. Capital stands behind all lines of business. The allocation by line and by geography is artificial.

B. Credit risk – risk that counterparties (insured, agents, reinsurers, etc) may not remit their obligations
   Asset risk – value of company's assets depreciate
   Asset/Liability mismatch risk – interest rate impacts value of assets and liabilities differently
   Pricing risk – premium is not enough to cover future expected losses and expenses
C. Whether capital is still being attracted to the industry and whether new firms are being formed. If so, a fair rate of return is present.

Solution 2

A. Each dollar of capital protects each line of insurance. So, because lines of business are not perfectly correlated, the required capital for a multi-line insurer will be less than the sum of the required capital if such capital were determined by line or geography.
B. Loss reserve risk – the risk that held loss reserves will be insufficient to cover loss obligations as they develop
   Investment risk – the risk that the expected investment income and gains will not be realized
   Cat risk – risk that a natural disaster or CAT occurs drawing on additional funds of the surplus
   Reinsurance risk – risk that an event that is reinsured is large and the reinsurer is not able to pay claims, so you are left with unanticipated losses that you need $ for, which comes from your surplus
C. Based on the Hope decision, companies should be able to earn a reasonable return similar to companies with the same risk. This can be judged by the criteria of new companies forming. If new companies are forming, then there is attractiveness to the industry which implies a reasonable (certainly not unreasonable) return.

<u>Question 17:</u>

Solution 1:

a) Sharpley Method.
Var(XYZ) = 250k
Var(ABC) = 1000k
Var(ABC+XYZ)= 2250k
Assume renewal case
R combined = 10k = XVar(XYZ+ABC) x = .004
Var(ABC+XYZ) = Var(x)+Var(y)+2Cov(x,y)
2250k = 250k + 1000k + 2Cov(x,y)
Cov(x,y) = 500k
At renewal
r_{xyz} = xx(var(xyz)+cov(xyz,abc)
= xx(250k+500k) = 3,333
r_{abc} = xx (Var(abc)+cov(xyz,abc))
= x(1000k + 500k) = 6.667

b) assume covariance share is based on average losses (not by event)
Covshare ^{xyz} = 2.5l/ 5k+2.5k x 2Cov(xyz, abc) = 1/3 x 1000k
Covshare^{abc} = 2/3x1000k

$r_{xyz} = x\ (Var(xyz)+Covshone^{xyz})$
$= x(250k + 1000k/3) = 2,593$
$r_{abc} = x(Var(ABC)+Covshare^{abc})$
$r_{abc} = x(1000k + 2000k/3\ ) = 7,407$

Solution 2:

a) Risk Load$_{xyz}$ = [Var$_{xyz}$+Cov(xyz,abc)/ Var$_{xyz}$+Var$_{abc}$+2Cov(xyz,abc)] X (total risk load of $10,000)
Coz(xyz,abc) = .5[(2000-2500)(4000-5000)]+.5[(3000-2500)(6000-5000)] = <u>500,000</u>
Risk load$_{xyz}$ = 250,000+500,000/250,000+1,000,000+2(500,000) X = $\boxed{3,333}$
So Risk Load$_{abc}$ = Total Risk Load$_{xyz}$ = 10,000-3,333 = $\boxed{6,667}$

b) Relative weight of xyz = (2,000/6,000) [(2,000-2500)(4,000-5,000)] + (3,000/9,000) x [(3,000-2,500)(6,000-5,000)] = [166,667+166,667]
Then Relative to total = 166,667x2/ 500,000x2 = $\boxed{1/3}$
So risk load$_{xyz}$ = [Var$_{xyz}$ + 91/3)(2Cov(xyz,abc))/Var$_{xyz}$+Var$_{abc}$+2Cov(xyz,abc)] x (10,000)
= [250,000+333,333/ 250,000+1,000,000+2(500,000)] x 10,000 = $\boxed{2,593}$ = Risk Load xyz
So RiskLoad ABC = 10,000-2593 = $\boxed{7,407}$ = Risk Load abc

Solution 3:

a) Shapely method share mutual covariance evenly
λ= 10,000/2,250,000 = 0.00444
xyz variance = 250,000 x 0.00444 = 1,110 $\longrightarrow$
abc variance = 1,000,000 x 0.00444 = 4.440 $\longrightarrow$ 5.550
10,000-5,500 = 4,450 = Mutual covariance
XYZ = 1110+4450/2 = 3,335XYZ
ABC = 4440+4450/2 = 6,665ABC

b) allocate loss$_{xyz}$/ Σloss$_{xyz}$+loss$_{abc}$ proportion of mutual covariance to XYZ

XYZ 4450 x 25/75 = 1483   <u>covariance share</u> risk bad
ABC4450 x 50/75 = 2967   assure pt(a) correct
Total RiskLoad
XYZ = 1483+1110 = 2593 XYZ
ABC = 2967+4440 = 7407 ABC

Solution 4:

a) Var(x+a) = Var(x)+Var(a)+2Cov(x,a) $R_{(x+a)} = \lambda Var_{(x+a)} = 10,000$
2,250,000 = 250k+1000k+2Cov(x,a) λ = 10,000/2,250,000
2Cov(x,a) = 1m
(.5)(2)Cov(x,a) = .5m
*Assume buildup method, w/xyz being 1st acct.
R_{xyz} = λ[Var(x)]=(10,000/2.25m)(250,000)$\boxed{1111.11}$
R_{abc} λ[Var(m)+(.5)(2)Cov(x,a)] = 10k/2.25m [1m+.5m] = $\boxed{6666.67}$
R_{xyz} defer = λ[(.5)(2)Cov(x,a)] = 2222.22

c) Assume buildup method
R_{xyz} = λVar(x) = (10,000/2.25m)(250k) = $\boxed{1111.11}$
R_{abc} = λ[Var(a)+CovShr(a)] = 10k/2.25m [(2/3)2Cov(x,a)+Var(a)] = $\boxed{7404.41}$

$R_{xyz} = \lambda[\text{Covshr}(x)] = 10k/2.25m[(1/3)2\text{Cov}(x,a)] = 1481.48$
$W_x = 2/6 + 3/4 = ½$ $\text{CovShr}(x) = (1/3)(2)\text{Cov}(x,a)$
$W_z = 2/3$ $\text{CovShr}(a) = (2/3)(2)\text{Cov}(x,a)$

Solution 5:

a)

Variance	XYZ	ABC
If added 1st	250,000	1,000,000
If added 2nd	2,250,000-1,000,000 = 1,250,000	2,250,000-250,000 = 2,000,000
Avg	750,000	1,500,000

Risk Load:
ABC = (1,500,000)(10,000/2,150,000) = 6,667
XYZ = (750,000)(10,000/2,250,000) = 3,333

b) 250,000 + 1,000,000 + 2Cov = 2,250,000   Cov = 500,000

Amt of covariance given to each Risk:
ABC = 2(500,000)(5000/7500)=666,667
XYZ = 2(500,000)(2500/7500) = 333,333
Total Variance:
ABC = (666,667)(10,000/2,250,000) = 7467
XYZ = (583,333)(10,000/2,250,000) = 2593

Question 18:

Scenario 1P – Use PAID loss; recognize all cash flows as they occur:

	T = 0	T = 1	T = 2	T = 3
Committed Capital	-100,000			
Released Capital				100,000
Paid Loss		-40,000	-35,000	-30,000
Collected Premium	P			
Admin Expense	-0.15P			
Inv Inc on Capital		5%*(100,000)	5%*(100,000)	5%*(100,000)
Inv Inc on Reserves		5%*P	5%*0.5P	5%*0.25P
Total Income	0.85P	0.05P-35,000	0.025P-30,000	0.0125P-25,000
After-tax Income	0.5525P	0.0325P-22,750	0.0163P-19,500	0.00813P-16,250

Set the discounted value of capital and after-tax income cash flows equal to zero:

$$0 = -100{,}000 + 0.5525P + \frac{0.0325P - 22{,}750}{1.15} + \frac{0.0163P - 19{,}500}{1.15^2} + \frac{0.00813P - 16{,}250 + 100{,}000}{1.15^3}$$

Solve for P = 132,790

Scenario 2P – Use PAID loss; recognize all income at end of year:

	T = 0	T = 1	T = 2	T = 3
Committed Capital	-100,000			

Released Capital				100,000
Paid Loss		-40,000	-35,000	-30,000
Collected Premium	P			
Admin Expense	-0.15P			
Inv Inc on Capital		5%*(100,000)	5%*(100,000)	5%*(100,000)
Inv Inc on Reserves		5%*P	5%*0.5P	5%*0.25P
Total Income Earned		0.9P-35,000	0.025P-30,000	0.0125P-25,000
After-tax Income		0.585P-22,750	0.0163P-19,500	0.00813P-16,250

Set the discounted value of capital and after-tax income cash flows equal to zero:

$$0 = -100{,}000 + \frac{0.585P - 22{,}750}{1.15} + \frac{0.0163P - 19{,}500}{1.15^2} + \frac{0.00813P - 16{,}250 + 100{,}000}{1.15^3}$$

Solve for P = 150,979

Scenario 3P – Use PAID loss; recognize cash flows as they occur, but pay taxes at end of year:

	T = 0	T = 1	T = 2	T = 3
Committed Capital	-100,000			
Released Capital				100,000
Paid Loss		-40,000	-35,000	-30,000
Collected Premium	P			
Admin Expense	-0.15P			
Inv Inc on Capital		5%*(100,000)	5%*(100,000)	5%*(100,000)
Inv Inc on Reserves		5%*P	5%*0.5P	5%*0.25P
Taxable Income for Year		*0.9P-35,000*	*0.025P-30,000*	*0.0125P-25,000*
Tax		-0.315P + 12,250	-0.00875P+10,500	-0.00438P+8,750
After Tax Income Cash Flow	0.85P	-0.265P-22,750	0.0163P-19,500	0.00813P-16,250

Set the discounted value of capital and after-tax income cash flows equal to zero:

$$0 = -100{,}000 + 0.85P + \frac{-0.265P - 22{,}750}{1.15} + \frac{0.0163P - 19{,}500}{1.15^2} + \frac{0.00813P - 16{,}250 + 100{,}000}{1.15^3}$$

Solve for P = 124,703

Scenario 4P – Use PAID loss; recognize expense at T=0 and premium as earned at T=1:

	T = 0	T = 1	T = 2	T = 3
Committed Capital	-100,000			
Released Capital				100,000
Paid Loss		-40,000	-35,000	-30,000
Earned Premium		P		
Admin Expense	-0.15P			
Inv Inc on Capital		5%*(100,000)	5%*(100,000)	5%*(100,000)

Inv Inc on Reserves		5%*P	5%*0.5P	5%*0.25P
Total Income	-0.15P	1.05P-35,000	0.025P-30,000	0.0125P-25,000
After-tax Income	-0.0975P	0.6825P-22,750	0.0163P-19,500	0.00813P-16,250

Set the discounted value of capital and after-tax income cash flows equal to zero:

$$0 = -100{,}000 - 0.0975P + \frac{0.6825P - 22{,}750}{1.15} + \frac{0.0163P - 19{,}500}{1.15^2} + \frac{0.00813P - 16{,}250 + 100{,}000}{1.15^3}$$

Solve for P = 154,713

Scenario 1I – Use INCURRED loss; recognize all cash flows as they occur:

	T = 0	T = 1	T = 2	T = 3
Committed Capital	-100,000			
Released Capital				100,000
Paid Loss		*-40,000*	*-35,000*	*-30,000*
Reserves	*P*	*0.5P*	*0.25P*	*0*
*Change in Reserves**	*-P*	*0.5P*	*0.25P*	*0.25P*
Incurred Loss	-P	0.5P-40,000	0.25P-35,000	0.25P-30,000
Collected Premium	P			
Admin Expense	-0.15P			
Inv Inc on Capital		5%*(100,000)	5%*(100,000)	5%*(100,000)
Inv Inc on Reserves		5%*P	5%*0.5P	5%*0.25P
Total Income	-0.15P	0.55P-35,000	0.275P-30,000	0.2625P-25,000
After-tax Income	-0.0975P	0.3575P-22,750	0.1786P-19,500	0.1706P-16,250

**Note: money paid into reserves is a negative cash flow, and released reserves are a positive cash flow*

Set the discounted value of capital and after-tax income cash flows equal to zero:

$$0 = -100{,}000 - 0.0975P + \frac{0.3575P - 22{,}750}{1.15} + \frac{0.1786P - 19{,}500}{1.15^2} + \frac{0.1706P - 16{,}250 + 100{,}000}{1.15^3}$$ S

olve for P = 172,515

Scenario 2I – Use INCURRED loss; recognize all income at end of year:

	T = 0	T = 1	T = 2	T = 3
Committed Capital	-100,000			
Released Capital				100,000
Paid Loss		*-40,000*	*-35,000*	*-30,000*
Reserves	*P*	*0.5P*	*0.25P*	*0*
*Change in Reserves**	*-P*	*0.5P*	*0.25P*	*0.25P*
Incurred Loss	-P	0.5P-40,000	0.25P-35,000	0.25P-30,000
Collected Premium	P			
Admin Expense	-0.15P			

Inv Inc on Capital		5%*(100,000)	5%*(100,000)	5%*(100,000)
Inv Inc on Reserves		5%*P	5%*0.5P	5%*0.25P
Total Income Earned		0.40P-35,000	0.275P-30,000	0.2625P-25,000
After-tax Income		0.26P-22,750	0.1786P-19,500	0.1706P-16,250

**Note: money paid into reserves is a negative cash flow, and released reserves are a positive cash flow*

Set the discounted value of capital and after-tax income cash flows equal to zero:

$$0 = -100{,}000 + \frac{0.26P - 22{,}750}{1.15} + \frac{0.1786P - 19{,}500}{1.15^2} + \frac{0.1706P - 16{,}250 + 100{,}000}{1.15^3}$$

Solve for P = 167,851

Scenario 3I – Use INCURRED loss; recognize cash flows as they occur, but pay taxes at end of year:

	T = 0	T = 1	T = 2	T = 3
Committed Capital	-100,000			
Released Capital				100,000
Paid Loss		*-40,000*	*-35,000*	*-30,000*
Reserves	*P*	*0.5P*	*0.25P*	*0*
*Change in Reserves**	*-P*	*0.5P*	*0.25P*	*0.25P*
Incurred Loss	-P	0.5P-40,000	0.25P-35,000	0.25P-30,000
Collected Premium	P			
Admin Expense	-0.15P			
Inv Inc on Capital		5%*(100,000)	5%*(100,000)	5%*(100,000)
Inv Inc on Reserves		5%*P	5%*0.5P	5%*0.25P
Taxable Income for Year		*0.40P-35,000*	*0.275P-30,000*	*0.2625P-25,000*
Tax		-0.14P+12,250	-0.0963P+10,500	-0.09188P+8,750
After-tax Income Cash Flow	-0.15P	0.41P-22,750	0.1786P-19,500	0.1706P-16,250

**Note: money paid into reserves is a negative cash flow, and released reserves are a positive cash flow*

Set the discounted value of capital and after-tax income cash flows equal to zero:

$$0 = -100{,}000 - 0.15P + \frac{0.41P - 22{,}750}{1.15} + \frac{0.1786P - 19{,}500}{1.15^2} + \frac{0.1706P - 16{,}250 + 100{,}000}{1.15^3}$$

Solve for P = 175,062

Question 19

a) Allocated Capital:125,000/(125,000+90,000) x 550,000 = 319,767
-(200,000(1-0.25)-319,767) = 319,767 – 0.7 x 200,000/ $(1+irr)^2 = 0$
irr = 2.9%

b) Allocated capital: 200/(200+100) x 550,000 = 366,667
$(200{,}000(1-.025)-366{,}667)+ 366{,}667/(1+irr) – 0.7x200{,}000/(1+irr)^2 = 0$
$-216{,}667+ 366{,}667/(1+irr) – 1400{,}00/(1+irr)^2$
$\boxed{irr = 11.04\%}$

c) The capital allocated is different because allocation by reserve takes the length of claim payment into account while allocation by premium does not so the payment pattern will be a big influence if we allocate by reserve.
The timing of surplus release and commitment is also different
Reserve sets surplus as loss occurs and releases as losses are fully paid.
Premium set surplus as policy is written and releases as policy expires.

Question 20
Part a:

Solution 1:
$CYROE = UWInc_{AFIT} + II_{AFIT}/ Equity$
$II_{AFIT} = i_{AFIT}(Surplus + PMSF) = .055(30{,}000+40{,}000) = 3850$
PHSF = PHSF % x EP = .4(100,000) = 40,000
PMSF% = [UEPR/EP(1-PPE)-PremRec/EP]+PLR(Res/IL)
=[30/100(1-.25)-15/100]+.65(.5) = .4
Surplus = .3(100,000) = 30,000 Eq = .6(100,000) = 60,000
.15 = UWInc+3850/60,000   UWInc = 5150
UWInc = U x P x (1-t) = U x 100,000 (1-.34)
$\boxed{U = 7.8\%}$

Solution 2:
CYROE: $V = 1/1-t_u[5(QSR/PSR)-i_{AFIT}(PHSR+ 1/PHSR)]$
= 1/1-.34[(.15)(2/3.333)-(.055)(.4+ 1/3.333) = .07803 = $\boxed{7.80303\%}$
QSR = Equity/Surplus   Equity/Premium = .6 = Equity/100,000 → E = 60,000
60,000/30,000 = 2   Surplus/Premium = .3 = Surplus/a00,000 → S = 30,000
Prem/Surplus = PSR = 100,000/30,000 = 3.333
PHSF= [VEPR/Premium(1-PPACQ)-Rec/Premium]+PLR(Rsv/Inc)
=[30,000/100,000)(1-.25)-15,000/100,000]+(.65)(.5) = .4

Part b:

Solution 1:
Adv: figures are readily available from financial statements and comparable to GAAP ROE commonly used as a measure of return for investors in other industries.
Disadv: Since it is a calendar year method, figures are distorted by rapid growth/decline in loss volumes and reserve adequacy.

Solution 2:
One advantage is that the data is easily obtained and verifiable from the annual statement

One disadvantage to the method is that you are forced to allocate surplus by line of business.

Solution 3:
Advantage = all values are in annual report. Very transparent and easy to understand.
Disadvantage = Must pick a return on equity target

Solution 4:
Advantage: Most of inputs are readily available in financial statement and industry expense exhibit.
Disadvantage: Subject to distortion caused by rapid growth or decline of business

Solution 5:
Advantage: Returns similar to GAAP return
Disadvantage: Need to allocate surplus

Solution 6:
Advantage – Produces return similar to GAAP ROE
Disadvantage – Need to select leverage ratios

Solution 7:
Adv – Cy. Data is from public financial statements → easy to verify
Disadv – Cy can be distorted by changed in case reserve adequacy leads

Solution 8:
Ad: Produces ROE similar to GAAP ROE
Dis: PLR selection process is iterative

Solution 9:
Advantages: 1) Produces a measure comparable to GAAP ROE
Disadvantage: Can be distorted by changes in reserve adequacy or premium growth.

Solution 10:
Produces ROE similar to GAAP ROE in other companies → advantage
Distorted by rapid growth in volume or reserve adequacy → disadvantage

Part c:

Solution 1:
Risk adjusted discounted cash flow method.

Solution 2:
The calendar year investment income offset method does not require allocating capital by line of business.

Solution 3:

Risk adjusted method uses CAPM to price a fair premium. No picking target return. Dictated by β.

Solution 4:
Internal rate of return method does not use calendar year value and therefore not subj. to distortion caused by rapid business growth or decline.

Solution 5:
Present value offset method does not need to allocate surplus.

Solution 6:
Present value offset method- No need to select leverage ratios.

Solution 7:
PV offset method not distorted to extent PLR is not affected

Solution 8:
Internal Rate of Return method does not require a PLR selection

Solution 9:
Present Value: Cash Flow Return Method

Solution 10
Use PVA/PVE method

Question 21:

Part a:

Solution 1:

$P = L[1-(PV_{HO}PV_{AL})]+F/\ 1-V-U_o$
$P = PV+PU_o+L-LPV_{HO}+LPV_{AL}$
$= PV+PU_o+L[1-PV_{HO}]+LPV_{AL}$
$PV_{AO}-60 = L_{HO}\ [.4*1.02^{-1}+.3*1.02^{-2}+.3*1.02^{-3}]$
$60 = .9632L_{HO}\ L_{HO} = 62.78$
$P = 62.78[1-(.9632-.9556)]+25/\ 1\text{-}.2\text{-}.05 = 116.4038293 = 62.78+25/\ 1\text{-}.2\text{-}U_{AL}$
$116.4038293-23.28076586-116.4038293U_{AL} = 87.78$
$U_{AL} = 4.6\%$
$CR = 1-.046 \quad \boxed{CR = 95.4\%}$

Solution 2:
$U = U^o - PLR\ [PV_{ref} - PV_{review}]$
$PV_{ref} = 40\%/1.02 + 30\%/1.02^2 + 30\%/1.02^3 = 96.32\%$
PV_{review} = “ “ “ = 95.56%
$U = 5\%-PLR[96.32\% - 95.56\%]$

$P= FX+L[1-(PV_{ref}-PV_{review})/1-VR-U^{o}$We are given present value of losses = 60. I backtrack the undiscounted value of losses: $60 = L \times PV_{review}$, $L = 62.79$
$P = 25+L-L9PV_{ref}-PV_{review})/ 1-20\%-5\%$
$P = 25+62.79-62.79[96.32\%-95.56\%]/ 1-20\%-5\%$
$P = 116.41$
Combined ratio = $62.79+25+20\%*116.41/ 116.41 = \boxed{95.41\%}$

Solution 3:
$PV_{auto} = .25/1.02 + .3/1.02^2 + .35/1.02^3 + .1/1.02^4 = .9556$
$PV_{HO} = .4/1.02 + .3/1.02^2 + .3/1.02^3 = .9632$
$Prem = PV(L)+FX+P(VarX)+U^{o}(P)+l(1-PV_{xo})$
$P = 60+25+.2P+.05P+62.79(1-.9632)$
$.75P = 87.31 \rightarrow \boxed{P = 116.41}$
Undise Loss = 60/.9556 = 62.79
Prem = 116.41
$U = P-L-E/P = (.8)116.41-60-25/116.41 = 8.13/116.41 = .0688 \approx 7\%$
Combined $\surd$ = $\boxed{.93}$ *
U = (1-cr)

Part b:

Solution 1:

a) Does not require allocation of surplus
Does not require selection of target return on equity

Solution 2:

a) It is not distorted by growth and reserve adequacy
It treats investment income in a simple manner.