SOCIETY OF ACTUARIES
Life Pricing

Exam ILALP

MORNING SESSION

Date: Wednesday, October 28, 2015
Time: 8:30 a.m. – 11:45 a.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 100 points. It consists of a morning session (worth 60 points) and an afternoon session (worth 40 points).

   a) The morning session consists of 6 questions <u>numbered 1 through 6</u>.

   b) The afternoon session consists of 4 questions <u>numbered 7 through 10</u>.

   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.

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 ILALP.

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.

1. (*8 points*) ABC Life is entering the variable annuity (VA) market and is evaluating a change to a risk based pricing methodology for measuring the profitability of these products.

(a) (*2 points*) ABC Life has assembled the following product development team:

- A marketing director who previously worked with many pricing teams and understands the basics of pricing work and pricing assumptions.
- A newly promoted director responsible for the product implementation who has strong information technology and systems knowledge.
- A legal director who recently joined the company from a consulting firm who has strong knowledge of health insurance regulations.
- A newly promoted VA pricing director with 5 years of experience in health insurance.

Critique the team structure and propose changes to increase the effectiveness of the team.

(b) (*5 points*) You are given the following assumptions for a VA product valued over a three year projection period:

- Earned rate is 7%
- Hurdle rate is 10%
- Risk-free rate is 4%
- Cost of nonhedgeable risk is 6% of the present value of nonhedgeable risk capital
- 60% of the economic capital is related to nonhedgeable risks
- Time value of financial options and guarantees is 15.0
- Frictional cost of required capital is 12.5

Year	1	2	3
After tax profit	−100	250	400
Required capital (end of year)	400	450	550
Economic capital (end of year)	300.0	337.5	412.5

1. **Continued**

Calculate the following profitability metrics using distributable earnings as the basis:

(i)   Internal rate of return (IRR)

(ii)   Traditional value of new business (VNB)

(iii)   Risk based VNB

Show all work.

(c)   (*1 point*) Explain why the GAAP ROI over the projected period is different than the IRR.

2. (*10 points*) NJK Life currently offers an Equity Indexed Annuity (EIA) with a Guaranteed Minimum Withdrawal Benefit (GMWB) and is planning to replace it with an EIA with a Guaranteed Withdrawal Benefit for Life (GWBL). The features of each product and rider are summarized below:

Product and Rider	Lifetime Flexible Deferral Period Option	First Year Commission (% of Premium)	Index Switch Option
EIA with GMWB	No	4%	No
EIA with GWBL	Yes	7%	Yes

- Lifetime Flexible Deferral Period Option: Allows a customer to earn a deferral bonus of 5% of Premium Paid for each year they wait until the first withdrawal.
- Index Switch Option: Customers can switch their index option at the end of the index period without charge.

(a) (*6 points*) For the new EIA with GWBL:

    (i) Assess the risks in the Lifetime Flexible Deferral Period Option from both a pricing and hedging perspective

    (ii) Evaluate the risk management concerns for the Index Switch Option

    (iii) Assess how an increase in first year commission may impact NJK Life and the customer in:

- An up market
- A down market

(b) (*4 points*) Recommend design alternatives to the EIA with GWBL to manage the risks of the following options:

    (i) Lifetime Flexible Deferral Period Option

    (ii) Index Switch Option

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3. (*13 points*) DEF is a Canadian Life insurance company and is adding a feature to its renewable level 10 year term life product (Term 10) which allows conversion to a permanent life insurance product.

    (a)   (*4 points*)

        (i)   (*1 point*) Describe the effect an optional conversion feature has on mortality and lapse rates and contrast it with an automatic conversion feature.

        (ii)   (*1 point*) Describe other mortality and lapse patterns that have been observed on post conversion policies.

        (iii)   (*2 points*) Describe the important considerations reinsurers must make when reinsuring term conversions.

    (b)   (*7 points*) For a policy that can be converted from a Term 10 policy into a Universal Life policy only at the end of policy year 10, you are given:

Pricing interest rate	3%
Probability policy is inforce at end of year 10	80%
Conversion rate at end of year 10	10%

	Year 11	Year 12
Death benefit at end of year	100,000	100,000
Premium at beginning of year	2,000	2,200
Fund value at end of year	750	1,400
Company mortality rate for standard policy	1.1%	1.4%
Company mortality rate for converted policy	1.5%	1.8%
CIA 1969-1975 mortality rate	1.8%	2.2%
Company lapse rate for converted policy	0%	0%

        (i)   (*4 points*) Assume that after year 12, the company mortality rate for a converted policy is equal to the company mortality rate for a standard policy.

            Calculate the present value at issue of the extra mortality cost due to conversion. Show all work.

3. **Continued**

     (ii)   (*3 points*) You are given:

- The policy has passed the exempt test
- The policyholder's tax rate is 35%
- The surrender charge is 40% of the fund value
- The Adjusted Cost Basis immediately before conversion was 0

     Calculate the after-tax proceeds of a full surrender of the policy at the end of the second year after conversion. Show all work.

  (c)   (*2 points*) Explain how the Adjusted Cost Basis would compare for a Universal Life policy that was converted from a Term 10 policy if there is a charge for the conversion option which is borne:

     (i)   only by those people who exercise the conversion option.

     (ii)   by everyone whether they want the conversion option available or not.

     Justify your answer.

4. (*9 points*) You are the actuary for ECC Life and have been asked to update the expense assumptions for your single premium 10 year term product.

A dataset containing ECC's expense data for the last 5 years has been prepared. The historical data has been tracked on a policy level and includes the cost of acquiring the policy and the maintenance expenses.

(a) (*1 point*) List expense data items that should be disclosed under ASOP No. 23.

(b) (*2 points*) You are given the following sample of 10 records taken from the dataset to help with the expense validation:

Policy ID	Issue Year	Issue Age	Sex (M / F)	Single Premium	Expenses by policy year				
					1	2	3	4	5
1252	2010	36	F	800.00	81.00	1.02	1.04	1.05	1.07
2070	2014	29	M	300.00	35.00				999.00
2717	2012	71	M	400.00	43.00	3.03	3.06		
2720	2012	50	F	1,000.00	102.00	2.02	2.04		
3211	2013	58		800.00	81.00	1.01			
3398	2011	42	M	800.00	81.00	1.01	1.03	1.05	
4039	2012	62	M	400.00	45.00	5.05	5.15		
4039	2012	62	M	400.00	45.00	5.05	5.15		
5039	2011	60	F	800.00	2.00	2.04	2.08	2.12	
5418	2010	43	M	300.00	32.00	10.00	10.00	10.00	10.00

(i) Identify the potential data errors in the sample provided.

(ii) Propose a method to correct each error.

(c) (*4 points*) The following method was proposed to set the policy expense assumptions:

Policy years 1 to 4: Use the average policy year expense for each year

Policy years 5 to 10: Use the average expense for policy year 5

Proposed Expense Assumptions by Policy Year				
1	2	3	4	5 to 10
58.91	3.24	3.30	3.38	3.40

Critique the proposed method. Recommend changes if appropriate.

4. **Continued**

    (d)   (*2 points*) ECC Life plans to build a predictive model to set expense assumptions.

        (i)   Explain how a dataset is partitioned when building a predictive model.

        (ii)   Describe how each dataset partition is used to build a predictive model.

5. (*12 points*) You are pricing a two year Guaranteed Minimum Accumulation Benefit (GMAB) rider on a variable annuity. You are given:

GMAB Rider Features

      GMAB Base: 10,000

      GMAB Annual Ratchet: GMAB Base ratchets to Account Value if higher at each policy anniversary

      Exercisable: Only at end of year two

Pricing Assumptions

      Premium: 10,000 invested in a Large Cap Fund

      Large Cap Fund Return: Returns are either 15% or -10% in each year; No other returns are possible

      Risk Free Force of Interest: 5% per year

(a) (*3 points*) Construct a 2-period binomial model showing the value of each of the following at the end of years 1 and 2:

    (i)   Account Value

    (ii)   GMAB Base

    (iii)   GMAB Payoff

(b) (*5 points*) Calculate the cost of exactly hedging the liability of this GMAB rider at issue. Show all work.

(c) (*4 points*)

    (i)   Calculate the risk neutral probability of the Large Cap Fund having an annual account value return of -10% in a given year. Show all work.

    (ii)   Assess the appropriateness of using the risk neutral probability measure to determine the chance of the option being in or out of the money. Justify your answer.

6. (*8 points*) NBD Life has been selling term life insurance on a social media website and has access to profile information for all users of the website whether they purchased an insurance policy or not.

(a) (*4 points*) NBD Life is building a predictive model that will be used to predict the likelihood that an insurance policy is purchased based on information available in a user's social media profile. Describe the steps required to build this model.

(b) (*4 points*) NBD Life is building a second predictive model that will be used to predict mortality rates of social media users. You are given the following generalized linear model with three variables (age, marital status, gender):

$$ LN\left(\frac{q_x}{1-q_x}\right) = -6.0 + 0.05 \times Age - 0.2 \times Marital\ Status - 0.1 \times Gender $$

Where: Marital Status = $\begin{cases} 1, & Married \\ 0, & Single \end{cases}$

Gender = $\begin{cases} 1, & Male \\ 0, & Female \end{cases}$

(i) (*2 points*) Assess the appropriateness of the impact that each model variable has on the predicted mortality rate.

(ii) (*2 points*) Explain any concerns you have about using this model to set mortality assumptions.

END OF EXAMINATION
Morning Session

USE THIS PAGE FOR YOUR SCRATCH WORK