INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 40 points. This exam consists of 4 questions, numbered 1 through 4.

   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 Exam ILALAM.

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

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Tournez le cahier d’examen pour la version française.
1. **(10 points)**

   (a) **(1.5 points)**

   (i) Describe the cluster modeling approach.

   (ii) Describe potential drawbacks of this approach.

   You are given the following seriatim extract and cluster model parameters:

<table>
<thead>
<tr>
<th>Policy</th>
<th>Age</th>
<th>Gender</th>
<th>Face</th>
<th>PV(Profit)</th>
<th>Reserve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27</td>
<td>M</td>
<td>1000</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>M</td>
<td>1050</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>F</td>
<td>1100</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>81</td>
<td>F</td>
<td>1200</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

   - Location Variables: PV(Profit), Reserve
   - Size Variable: Face Amount
   - Compressed number of policies: 1

   (b) **(6.5 points)** Calculate the age of the seriatim record created by the cluster modeling approach. Show all work.

   (c) **(2 points)** Critique the following statement:

   “Reserve replication techniques are superior to cluster modeling.”
2. **(11 points)**

(a) **(2 points)** For the following indexation methods:

- Multi-Year Point-to-Point (PTP)
- Annual Ratchet
- High Water Mark

(i) **Describe the characteristics of each method.**

(ii) **Compare the cost of each method.**

SLC Life is developing an Equity-Indexed Annuity (EIA) product with the following features:

- Single premium of 2,000
- 3-year maturity
- Annual ratchet with a 70% participation rate subject to a 10% cap and 0% floor
- Guaranteed minimum annual interest of 3% on the entire premium
- Surrender charge of 100 for early withdrawals

You are given the following:

- A European call option with the same term and strike is valued at 45
- The current risk-free rate is 4% annual effective compounding

(b) **(2 points)** Calculate the value of the guaranteed minimum annual interest feature using the Put-Call Parity. Show all work.

You are given the following index values:

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index Level</td>
<td>12,500</td>
<td>11,000</td>
<td>12,750</td>
</tr>
</tbody>
</table>

(c) **(3 points)** Calculate the EIA surrender value at the end of each policy year. Show all work.

(d) **(2 points)** SLC Life plans to use a traditional deterministic valuation for the EIA product. Critique this decision.

(e) **(2 points)** Describe four assumptions required to value the above EIA product under a risk-neutral stochastic framework.
3. (8 points) You are reviewing the ALM practices of YYZ Insurance. YYZ has blocks of
term, participating whole life, immediate annuities, and deferred annuities.

YYZ uses the following investment strategies:

- One asset portfolio is used to back all liabilities
- Assets with terms to maturity greater than 10 years are purchased
- Duration matching is the only ALM criteria considered
- Asset and liability cashflows are projected on a statutory basis

(a) (2 points) Critique these strategies and propose improvements if needed.

YYZ’s participating whole life product offers a policy loan feature that allows the
policyholder to borrow against the policy’s cash value at a rate specified in the contract.

(b) (4 points)

(i) Describe the embedded options of this feature from YYZ’s perspective.

(ii) Explain the ALM risks created.

(iii) Propose risk mitigation strategies.

YYZ is considering selling a Universal Life product that credits 50 basis points above
LIBOR. YYZ will back the liability with the following assets:

- 10-year bond yielding 4%
- Interest rate swap that receives LIBOR and pays 3% fixed

(c) (2 points) Recommend if YYZ should sell this product. Justify your response.
4. *(11 points)* BWI Life sells 20-year term life insurance. BWI is considering stochastically modeling its mortality and lapse risks.

(a) *(1 point)* Describe the benefits of using stochastic modeling techniques instead of traditional deterministic techniques for non-financial risks.

(b) *(3 points)* BWI performed sensitivity tests on the assumptions in its deterministic models with the following impacts to surplus:

<table>
<thead>
<tr>
<th></th>
<th>+5%</th>
<th>+10%</th>
<th>-5%</th>
<th>-10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Mortality</td>
<td>-20</td>
<td>-42</td>
<td>18</td>
<td>38</td>
</tr>
<tr>
<td>Base Lapse</td>
<td>-3</td>
<td>-5</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>+1% all ages</th>
<th>-1% all ages</th>
<th>+2% all ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality Improvement</td>
<td>2</td>
<td>-2</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles Outbreak</td>
<td>-33</td>
<td>-55</td>
</tr>
<tr>
<td>Terrorist Attack</td>
<td>-16</td>
<td>-48</td>
</tr>
</tbody>
</table>

Recommend variables that should be modeled stochastically and variables that should be modeled deterministically based upon the above results. Justify your answer.

(c) *(2 points)* BWI runs its stochastic model and compares the results to its deterministic model as follows:

<table>
<thead>
<tr>
<th></th>
<th>Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic Best Estimate</td>
<td>105</td>
</tr>
<tr>
<td>Average of all Stochastic Results</td>
<td>35</td>
</tr>
</tbody>
</table>

Interpret the results as they relate to the validity of the stochastic model.
4. Continued

(d) (5 points) BWI wants to examine the impact of reinsurance on the tail mortality and lapse risks in their stochastic models. BWI is considering the following reinsurance arrangements for its term block:

A. Excess over 250,000 under a Yearly Renewable Term (YRT) agreement
B. 100% reinsured with an experience refund under a YRT agreement
C. Multi-Year Stop Loss

Evaluate how each reinsurance arrangement would impact BWI’s cash flows under each of the following situations:

(i) If a pandemic event occurred.

(ii) If future mortality experience is better than expected in the years following the pandemic.

**END OF EXAMINATION**
USE THIS PAGE FOR YOUR SCRATCH WORK