Ma 418 ~ Actuarial Mathematics I

Capstone Project

This is the start of a project that will culminate in Ma 419. This semester you will focus on developing two life tables, computing premiums and policy values. The project will be collected in two stages: the life tables, and the policy premiums/valuations. You should plan to complete relevant portions of the project prior to the in-class test on the corresponding material.

Due to the time investment necessary for this project as well as the significant contribution it can make to your learning, it will be worth 300 points, 125 and 175 points respectively per section.

There are several goals for this assignment.

- To help you develop your understanding of life tables and the computations involved in premium determination and policy valuation.
- To help you develop your ability to handle larger, less well-defined problems than homework and exam problems provide.
- To help you develop your R/Excel skills.
- To help you develop your communication skills.

You can effectively be graded on the first and last goals based on what you submit. The cost for failure to develop the second and third goals will not primarily be academic - the cost will be your time (now and on future projects).

For each submitted assignment, you are also to submit a work log (see form provided) that documents the days/times you worked on this project and what you accomplished. Handwritten (neatly) or typed is acceptable (see Work Log Excel file on the course webpage), but you must keep up with it as you work (don't assume you'll remember what happened later).

Life Tables:

1. Read the provided documentation carefully. You are NOT permitted to do any additional online research on the specific life tables related to this document. This includes the life table workbook provided with the LTAM tables.
2. You are to create two life tables with a column corresponding to each column in the LTAM Tables as well as a column for remaining life expectancy, one for males and one for females. Assume a fixed interest rate of 5%.
3. The provided document will not contain everything you need to construct the life tables. Additional data will be available upon *specific* request. You need to know exactly what you want prior to asking. All requests must be done in writing and submitted at least one business day prior to when the information is needed. Information will be supplied by email and is NOT to be shared.

4. Present your life tables neatly formatted, easy to read, one page wide for each table (should be no more than 2-3 pages long).

5. Since everything relies on q_x, include a one page summary (predominantly in English however formulas are allowable) outlining how these values were found. Assume your audience for this is knowledgeable in the area of actuarial mathematics, just unfamiliar with your work. Be sure to define all notation even if it is standard notation.

6. Consider a force of mortality given by $\mu_x = a + be^{cx}$. Use a least squares method to find values for a, b, and c that will give μ_x that most closely matches the values for q_x in your table. (The nonlinear solver in Excel can handle this for you.) Present your model and demonstrate that it fits your data well.

DUE ONLINE: OCTOBER 21, 2021, 11:59PM

PREMIUMS AND POLICY VALUATION

1. Define a non-trivial insurance policy for yourself. Assume your own mortality follows the tables that you developed.

2. Assume that the interest rate for the first year is fixed at $i_0 = 5\%$ and that the interest for year k, i_k, is a normally distributed random variable (RV) with mean i_{k-1} and standard deviation 0.5%. You can generate uniform RVs in Excel using RAND() and then use NORM.INV to find the normally distributed value using the randomly generated probability (the value from RAND()). One you have generated random values you will probably want to copy and paste as values those numbers (so they stop changing on you every time you type something).

3. Compute the following premiums:

   (a) net premium if $i = 5\%$ (do this one first) and if i varies as described above.

   (b) gross premium (you will need to define your expenses) if $i = 5\%$ and if i varies as described above.

   (c) premium that will ensure that in a portfolio of 100 similar policies there is at most a 1% chance that the loss to the insurance company will be positive. if $i = 5\%$ and if i varies as described above (for this you may need to estimate some values based on simulation).

4. Compute the policy value at the time the policy is issued and after the 10th year for each of the three premiums that you computed.

5. Present two written documents. The first is a mathematical justification of your numerical answers (typed or neatly handwritten). The second is a report to your manager succinctly summarizing the policy and the computed values (typed). Presentation and clarity matters in both reports.

DUE ONLINE: DECEMBER 7, 2021, 11:59PM

MA 418 ~ ACTUARIAL MATHEMATICS I NAME: _____

LIFE TABLES RUBRIC ~ 125 POINTS

_____/ 5% Clarity, ease of read, presentation of tables, etc

_____/ 15% Explanation of tables/computations

_____/ 70% Table completeness/accuracy

x l_x q_x $\ddot{a}_x$ A_x ${}^2A_x$ $\ddot{a}_{x:\overline{10}|}$ $A_{x:\overline{10}|}$ $\ddot{a}_{x:\overline{20}|}$ $A_{x:\overline{20}|}$ ${}_5E_x$ ${}_{10}E_x$ ${}_{20}E_x$ e_x

_____/ 10% Model for force of mortality, $\mu_x = a + be^{cx}$

_____/ 125 pts

PREMIUMS AND POLICY VALUATION RUBRIC ~ 175 POINTS

_____/ 65% Clear policy definition/appropriate premiums (clearly explained)

Net (5%, varying); Gross (5%, varying); Portfolio (5%, varying)

_____/ 25% Valuation ($t = 0$ and $t = 10$)

_____/ 10% Policy Summary Report (neat, easy to read, clear, etc)

_____/ 175 pts