This is the expansion of the project that you started in Ma 418. This semester you will focus on developing more sophisticated policies, computing their premiums and policy values, and profit testing both your single life and multi-state policies. The project will be collected in two stages: multiple state model and profit testing. You should plan to complete relevant portions of the project as the topics are discussed in class for most efficient learning. 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 420 points.

There are several goals for this assignment.

- To help you develop your understanding of advanced policies and the computations involved in premium determination, policy valuation, and profit testing.
- To help you develop your ability to handle larger, less well-defined problems than homework and exam problems provide. Feel free to ask questions if any portion of the assignment is not clear.
- To integrate skills learned in other courses and help you develop your R and communication skills.

Work Log: You are to maintain a work log for this project. It should include the following information: Date and number of hours spent (rounded to the nearest 15 minutes), task accomplished during that time, and total time invested to date.

Reflection

Reflection is an important part of your learning and professional development. It gives you the opportunity to reflect on your personal growth during and evaluate how a current project fits into your career path. This reflection will ask you to address the four questions listed below.

1. Course Connections: How has your experience in the Ma 418 and 419 projects connected to learning (ideas/theory, facts, skills, applications) you have done in courses (or work-experience) in your chosen field?
2. Career Competencies: How did your career competencies grow as a result of your project experience this year? (Specifically reference the NACE Career Competencies listed.)

   NACE Career Competencies:

   - Critical thinking/problem-solving
   - Oral/written communication
   - Teamwork/collaboration
   - Digital technology
   - Leadership/initiative
   - Professionalism/work ethic
   - Career management
   - Global intercultural fluency

3. Critical Thinking: What problems did you solve related to your project experience this year? How did you solve the problems?

4. Creation-Fall-Redemption (CFR) Worldview: How has your project experience helped you develop an understanding of actuarial science that is consistent with the biblical arc of creation-fall-redemption?

This paper is an essay style paper. Each question should comprise its own section (word count per section: 150 - 600 - more is not necessarily better) with each section clearly labeled. This reflection will be collected in five parts, an initial draft for each question based predominantly on your experience from last semester, and a final draft of all four questions incorporating the work from both the 418 and 419 projects. Your final draft should be revised appropriately based on the feedback provided on your initial drafts.

Course Connections Initial Draft (5 pts)

Due Online: January 15, 2024, 11:59pm

Career Competencies Initial Draft (5 pts)

Due Online: January 17, 2024, 11:59pm

Critical Thinking Initial Draft (5 pts)

Due Online: February 7, 2024, 11:59pm

CFR Worldview Initial Draft (5 pts)

Due Online: February 12, 2024, 11:59pm

Final Reflection (40 pts)

Due Online: April 15, 2024, 11:59pm

Multiple State Model - Standard Sickness-Death Policy

R Initialization: Create an R project to contain all your work and save your environment/history and an R Markdown file to contain your code and the outputs. Expectations for organization/structure/documentation of your code are to do better than you did last fall. You will be expected to submit both your R code and an HTML knitted file. Easy navigation of the knitted file through a table of contents is appreciated.

Probabilities and EPVs:

1. Consider the standard sickness-death policy (see your textbook for the model). Use the forces of transition defined to manually compute transition probabilities. You are to present a table including μ_x^{ij}, ${}_{\frac{1}{12}}p_x^{ij}$, and ${}_xp_0^{ij}$ for all possible i, j combinations for ages 0 through 110.

   Additional assumptions or estimations made need to be introduced. These should be clearly stated, and the "best" option should be chosen.

   Each computation should be clearly developed in your RMarkdown file (include a description/explanation of the computation prior to the computation). You may wish to use Latex for adding math equations to your RMarkdown.

2. You may assume that no person will change state more than one time in any given month. You may also assume a constant interest rate of 5% unless otherwise stated.

3. Assume a payment of \$2500 will be made at the end of each month in which the insured is ill until age 72, for an insured who is either in a healthy or sick state at age x. Manually compute the actuarial present value of this annuity and add it to your table.

4. Assume a payment of \$100,000 will be made at the end of the month in which the insured dies for an insured who is either in a healthy or sick state at age x. Manually compute the actuarial present value of this insurance and add it to your table.

5. Present your table neatly formatted, easy to read, preferably one page wide (you may wish to export the required values to Excel for easier formatting).

Premiums and Reserving:

1. Given the previously defined illness and death benefits, and assuming that premiums are payable monthly until age 72 if the insured is healthy at the time of renewal and are suspended if the insured will receive a sick benefit that month.

2. Given initial expenses are \$150 plus 40% of the premium, annual renewal expenses are \$15 plus 5% of the premium with an additional cost of \$50 if the insured will receive a sick benefit that month, expenses at the time a sick benefit is paid are \$25, and expenses at the time a death benefit is paid are \$300 plus 2% of the issue amount.

3. Computes a net and gross premium for a policy issued to a person (25) as well as the valuation from time of issue forward for both premiums assuming the patient is in a healthy state at time 25 (assume that all premiums owed are paid).

4. Present your premiums and table of valuations neatly formatted and easy to read.

Meetings: Schedule a meeting with your professor during the week of January 22 to discuss your progress and your plan for next steps. Submit your work log in advance of the meeting. Come prepared to give an update on your progress and have at least two questions you have about the project, your project planning, or problems you are or anticipate having. This meeting will a graded activity and your grade will be based on your preparation for the meeting, your completion of work, and your participation in the discussion (the more ownership of this meeting you take, the better your grade will be).

Meeting Completed (20 pts) by: January 26, 2024, 3:00pm

Standard Sickness-Death Policy Submission: Your submission should include your work log, a pdf of your tables (one page wide if possible), your RMarkdown file, and a knitted HTML file of your RMarkdown file. Your RMarkdown file should contain every command needed to generate your solution and should be documented well enough that the computations are easy to follow.

Standard Sickness-Death (150 pts)

Due Online: February 1, 2024, 11:59pm

Standard Sickness-Death Revision: Recompute any columns in your tables that have incorrect values and resubmit the Standard Sickness-Death deliverables in their entirety. You may wish to confirm with your professor that your corrections are right before resubmitting them. You are welcome to get additional help from your professor. You may not continue with the project until you have correct values. If there were no errors in your life table, you do not need to resubmit anything.

Standard Sickness-Death Revision (20 pts)

Due Online: February 13, 2024, 11:59pm

Profit Testing

1. Clearly restate the basis for and the details of your Ma 418 life policy and your Multiple States Policy.
2. Construct a cash flow table for each policy.
3. Compute the profit signature for each policy.
4. Compute the various profit measures and draw conclusions about the profitability of your policies based on your work.

Meetings: Schedule a meeting with your professor during the week of March 25 to discuss your progress and your plan for next steps. Submit your work log in advance of the meeting. Come prepared to give an update on your progress and have at least two questions you have about the project, your project planning, or problems you are or anticipate having. This meeting will a graded activity and your grade will be based on your preparation for the meeting, your completion of work, and your participation in the discussion (the more ownership of this meeting you take, the better your grade will be).

Meeting Completed (20 pts) by: March 29, 2024, 3:00pm

Profit Testing Submission: Your submission should include your work log, a pdf of your table/signatures (one page wide if possible), your RMarkdown file, a knitted HTML file of your RMarkdown file, and a written summary presenting your conclusions about the profitability of your policies (citing evidence for your claims). Your RMarkdown file should contain every command needed to generate your solution.

Profit Testing (150 pts) Due Online: April 9, 2024, 11:59 pm

Reflection Drafts ∼ 20 points

	Exemplary (4.5-5)	Acceptable (3.5-4)	Developing (0-3)	Score
Course Connections: student will be able to connect the project to other learning	Word-count ≥ 150; Draws conclusions between the project and coursework by combining relevant specific examples, facts, or theories from both inside and outside your field of study or perspective.	Word-count ≥ 150; Draws conclusions between the project and other courses by combining relevant examples, facts, or theories from either your field of study or another discipline.	Word-count < 150; Draws general conclusions between the project and other courses in your discipline, or attempts to make connections that are not relevant.	
Career Competencies: student will be able to grow career competencies through the project.	Word-count ≥ 150; Assesses how the project furthered your career skill set by giving specific evidence for growth in four or more career competencies in light of the project.	Word-count ≥ 150; Assesses how the project furthered your career skill set by giving specific evidence for growth in only two or three career competencies in light of the project.	Word-count < 150; Assesses how the project furthered your career skill sets by giving specific evidence for growth in only one career competency in light of the project.	
Critical Thinking: student will be able to solve problems related to the project.	Word-count ≥ 150; Clearly defines a complex problem encountered in the project. Demonstrates how you applied skills, abilities, theories, or methodologies to solve the problem.	Word-count ≥ 150; Defines a problem encountered in the project. Applies general learning to solve the problem encountered.	Word-count < 150; Adapts and applies general learning to the work encountered in the project.	
CFR Worldview: student will be able to connect the project to biblical worldview.	Word-count ≥ 150; Uses specific examples to connect the project with each part of CFR model and relates them to major ideas in Scripture. Explains clear and detailed strategies to counter distortions or fallenness.	Word-count ≥ 150; In general terms, connects the project with each part of the CFR model and relates them to general ideas in Scripture. Mentions strategies to counter distortions or fallenness.	Word-count < 150; Deals with some parts of the CFR model. Does not adequately connect the project with the CFR model or to ideas in Scripture. Omits or only mentions strategies to counter distortions.	

REFLECTION ~ 40 POINTS

	Exemplary (9-10)	Acceptable (7-8)	Developing (0-6)	Score
Course Connections: student will be able to connect the project to other learning	Word-count ≥ 150; Draws conclusions between the project and coursework by combining relevant specific examples, facts, or theories from both inside and outside your field of study or perspective.	Word-count ≥ 150; Draws conclusions between the project and other courses by combining relevant examples, facts, or theories from either your field of study or another discipline.	Word-count < 150; Draws general conclusions between the project and other courses in your discipline, or attempts to make connections that are not relevant.	
Career Competencies: student will be able to grow career competencies through the project.	Word-count ≥ 150; Assesses how the project furthered your career skill set by giving specific evidence for growth in four or more career competencies in light of the project.	Word-count ≥ 150; Assesses how the project furthered your career skill set by giving specific evidence for growth in only two or three career competencies in light of the project.	Word-count < 150; Assesses how the project furthered your career skill sets by giving specific evidence for growth in only one career competency in light of the project.	
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Ma 419 Actuarial Math Rubric Name:

Meetings ∼ 20 points

_____/ 50% Work log submitted, appropriate time invested and progress made

_____/ 25% Prepared for the meeting with updates of progress and questions

_____/ 25% Managed the meeting well

_____/ 20 pts

Ma 418 Actuarial Math Rubric Name:

Meetings ∼ 20 points

_____/ 50% Work log submitted, appropriate time invested and progress made

_____/ 25% Prepared for the meeting with updates of progress and questions

_____/ 25% Managed the meeting well

_____/ 20 pts

STANDARD SICKNESS-DEATH RUBRIC ~ 150 POINTS

_____/ 12% Force of transitions μ_x^{01} μ_x^{02} μ_x^{10} μ_x^{12} , additional force assumptions stated, best assumptions used and supported

_____/ 48% Probabilities of transitions

$_{\frac{1}{12}}p_x^{00}$ $_{\frac{1}{12}}p_x^{01}$ $_{\frac{1}{12}}p_x^{02}$ $_{\frac{1}{12}}p_x^{10}$ $_{\frac{1}{12}}p_x^{11}$ $_{\frac{1}{12}}p_x^{12}$ $_xp_0^{00}$ $_xp_0^{01}$ $_xp_0^{02}$ $_xp_0^{10}$ $_xp_0^{11}$ $_xp_0^{12}$

_____/ 14% Sick annuity EPV and death benefit EPV computations $2500*12\ddot{a}^{(12)\ 01}_{x:\overline{72-x}|}$ $100000\bar{A}_x^{(12)\ 02}$

_____/ 10% Net and gross premium computations P^n P^g

_____/ 16% Valuation computations $_xV_n^0$ $_xV_n^1$ $_xV_g^0$ $_xV_g^1$

_____/ 0% Penalty: failure to follow directions, lack of professionalism, lack of clarity, etc.

_____/ 150 pts

STANDARD SICKNESS-DEATH REVISION ~ 20 POINTS

_____/ 20 pts Table completeness/accuracy

μ_x^{01} μ_x^{02} μ_x^{10} μ_x^{12} $_{\frac{1}{12}}p_x^{00}$ $_{\frac{1}{12}}p_x^{01}$ $_{\frac{1}{12}}p_x^{02}$ $_{\frac{1}{12}}p_x^{10}$ $_{\frac{1}{12}}p_x^{11}$ $_{\frac{1}{12}}p_x^{12}$

$_xp_0^{00}$ $_xp_0^{01}$ $_xp_0^{02}$ $_xp_0^{10}$ $_xp_0^{11}$ $_xp_0^{12}$ $2500*12\ddot{a}^{(12)\ 01}_{x:\overline{72-x}|}$ $100000\bar{A}_x^{(12)\ 02}$

P^n P^g $_xV_n^0$ $_xV_n^1$ $_xV_g^0$ $_xV_g^1$

Profit Testing $\sim$ 150 points

_____/ 40% Accurate cash flow table for each policy under a reasonable profit testing basis

_____/ 20% Accurate profit signature computed for each policy

_____/ 40% Profit measures computed computed for each policy; reasonable, clearly supported claims regarding profitability for each policy

$NPV_{r\%}$ Partial $NPV_{r\%}$ IRR DPP

Profit Margin Profitability Conclusions

_____/ 0% Penalty for poor presentation, failure to follow directions, lack of clarity, etc.

_____/ 150 pts